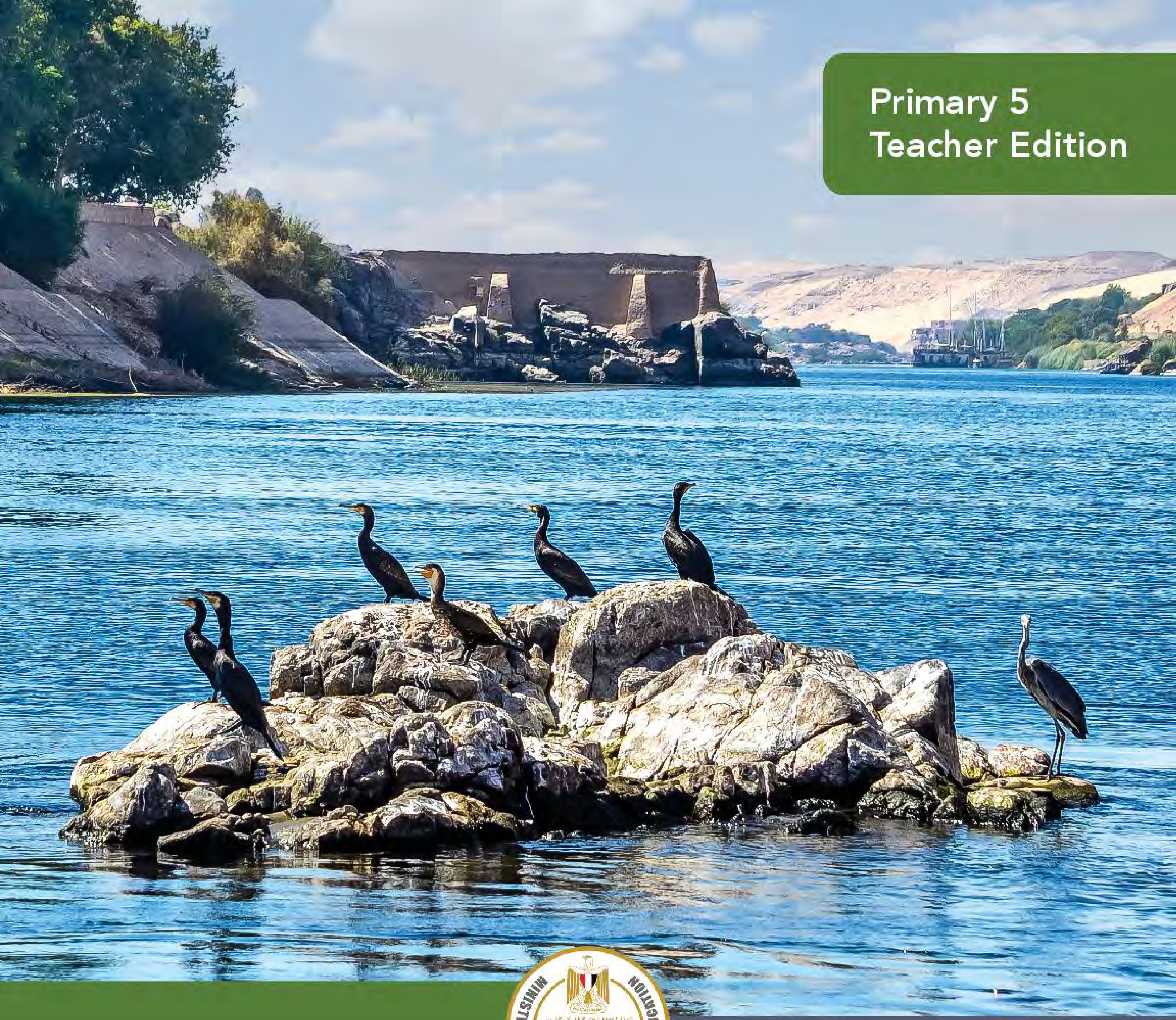
Primary 5
Teacher Edition

Science Term 1

2022–2023



Primary 5
Teacher Edition

Science Term 1

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FOREWORD

This is a pivotal time in the history of the Ministry of Education and Technical Education (MOETE) in Egypt. We are embarking on the transformation of Egypt's K-12 education system. We started in September 2018 with the rollout of KG1, KG2 and Primary 1, followed by Primary 2 through Primary 4. In 2022 we have rolled out Primary 5, and we will continue with the rollout until 2030. We are transforming the way in which students learn to prepare Egypt's youth to succeed in a future world that we cannot entirely imagine.

MOETE is very proud to present this new series of textbooks, with the accompanying digital learning materials that captures its vision of the transformation journey. This is the result of much consultation, much thought and a lot of work. We have drawn on the best expertise and experience from national and international organizations and education professionals to support us in translating our vision into an innovative national curriculum framework and exciting and inspiring print and digital learning materials.

The MOETE extends its deep appreciation to its own "Center for Curriculum and Instructional Materials Development" (CCIMD) and specifically, the CCIMD Director and her amazing team. MOETE is also very grateful to the minister's senior advisors and to our partners including "Discovery Education," "National Geographic Learning," "Nahdet Masr," "Longman Egypt," UNICEF, UNESCO, and WB, who, collectively, supported the development of Egypt's national curriculum framework. I also thank the Egyptian Faculty of Education professors who participated in reviewing the national curriculum framework. Finally, I thank each and every MOETE administrator in all MOETE sectors as well as the MOETE subject counselors who participated in the process.

This transformation of Egypt's education system would not have been possible without the significant support of Egypt's current president, His Excellency President Abdel Fattah el-Sisi. Overhauling the education system is part of the president's vision of 'rebuilding the Egyptian citizen' and it is closely coordinated with the ministries of Higher Education & Scientific Research, Culture, and Youth & Sports. Education 2.0 is only a part in a bigger national effort to propel Egypt to the ranks of developed countries and to ensure a great future to all of its citizens.

Words from the Minister of Education & Technical Education

Dear students and fellow teachers,

It gives me great pleasure to celebrate this crucial stage of comprehensive and sustainable development, an epoch in which all Egyptian people are taking part. This pivotal stage necessitates paving a foundation for a strong educational system which yields a generation that is not only capable of facing the major challenges the world is witnessing today, but one that also has complete possession of the skills of the future.

At a time when our world is witnessing successive industrial revolutions, the Egyptian state is keen on empowering its citizens by establishing a top-notch educational system that invests in its children the expertise required to get them to compete at both a regional and global level. This dictates that our educational system has at its core an emphasis on skills development, deep understanding, and knowledge production. This can only be done through modern curricula that keep up with the changes taking place globally— curricula which prioritize the development of skills and values, and the integration of knowledge. They are also curricula that focus on the provision of multiple learning sources, and integration of technology to enrich the educational process and to improve its outcomes, while addressing the most important contemporary issues.

To achieve this, we must all join hands to continue to revolutionize our education, and to support it with all that is required to transform it into a globally pioneering educational system.

My warmest regards to you, dear students, and my deepest gratitude to my fellow teachers.

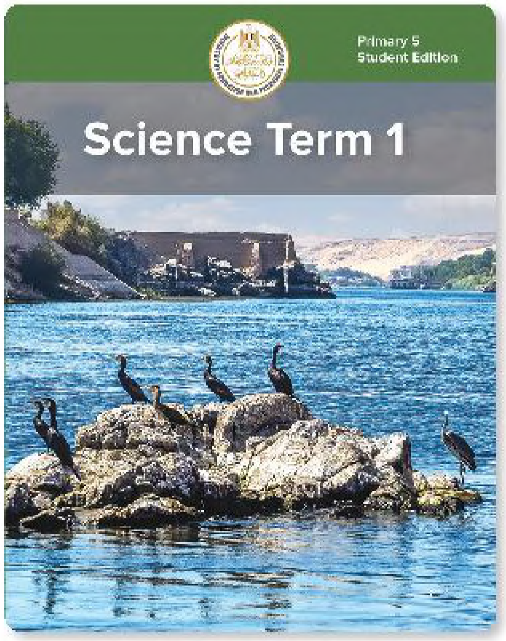
Professor Reda Hegazy

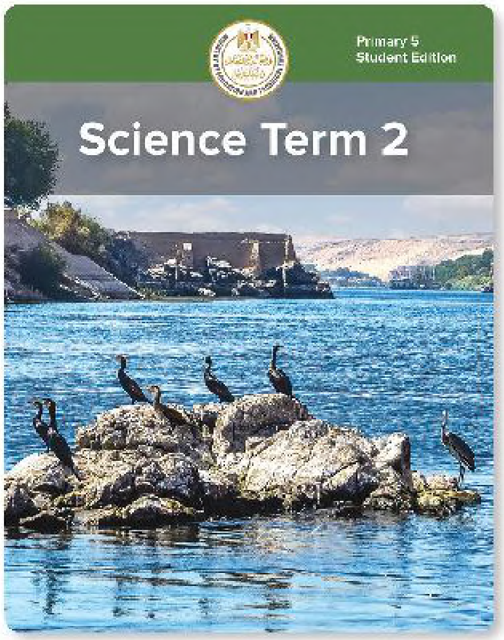
Minister of Education and Technical Education

Welcome to Primary 5 Science Techbook!

Students all over the world are natural explorers, filled with curiosity and innovative ideas. Science helps all of us understand and make sense of the world. Scientific reasoning helps students search for solutions to real-world challenges and to ask new questions as learners and thinkers. As you read the new Primary 5 student and teacher instructional resources, keep a few things in mind:

- The Primary 1 through Primary 3 multidisciplinary curriculum, Discover, implemented across Egypt starting from 2018 to 2020, helped lay a foundation for young students to inquire, observe, and think like scientists.
- The Primary 5 science content builds upon the success of Primary 4, with a similar design for both teachers and students. The Primary 5 Science Techbook includes engaging content, Hands-On Investigations, and content that provides students with opportunities to think, observe, analyze, and evaluate like scientists.
- The Primary 5 science curriculum is called a Techbook™. The Techbook is more than just print. It is a 21st-century instructional resource designed to inspire and empower all students through digital and print learning. The program has content in both print and digital locations so that students can learn whether they have access to the print book or digital version.





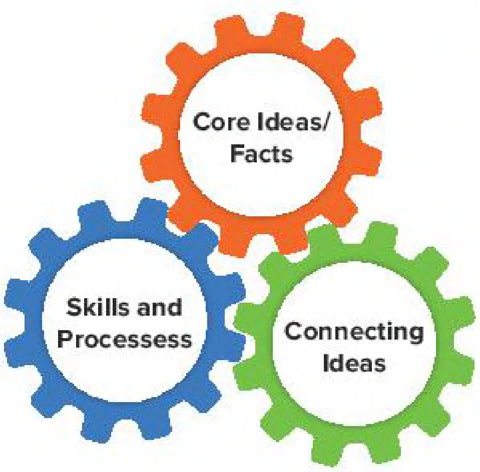
Program Philosophy

The Primary 5 Science Techbook was designed and written to align to the Ministry of Education Primary 5 science learning standards. These standards are internationally benchmarked, providing students in Egypt with a rigorous framework of learning targets.

The first step in building the Primary 5 framework was the adoption of new standards and specific grade-level indicators for learning in physical science, life science, earth and space science, environmental science, and engineering design and processes. These standards are integrated across three dimensions:

- disciplinary core ideas (such as energy transformations or the structure of cells),
- science skills and processes (such as asking questions to plan investigations, developing models, communicating scientific information), and
- connecting ideas that carry over across disciplines (such as cause and effect, systems, patterns).

This approach to teaching science is referred to as three-dimensional learning. Science is much more than an accumulation of facts; it is an intersection of three dimensions: facts, skills and processes, and connecting ideas.



- Core ideas have broad importance, are key organizing concepts, and provide tools for complex ideas.
- Skills and processes combine the behaviors that scientists engage in and the key engineering practices that they use.
- Connecting ideas link the different domains of Science.

The intersection of these three dimensions provides the foundation for the scientific content in Primary 5. The structure of Primary 5 Science Techbook also embodies the Ministry's shifts in the Framework for Education 2.0., specifically focusing on:

- student-centered learning;
- providing opportunities for authentic investigation by prioritizing hands-on learning; and
- creating globally prepared students by integrating career, technology, entrepreneurship, and life skills.

Student-Centered Learning: Wonder • Learn • Share

Students are at the heart of Primary 5 science instruction. Students act as scientists and engineers to investigate problems and construct solutions. Students conduct research and develop scientific explanations for phenomena. Students build and test prototypes and determine the best solutions based on the collection and analysis of data. By exploring real-world situations and articulating original questions with teacher support, students actively construct scientific knowledge and identify ways to improve and extend human capabilities.

To help drive a student-centered approach to learning, Primary 5 Science Techbook is organized by the Wonder-Learn-Share sequence. This sequence may be a change from how science has been taught previously, but having students think about the natural phenomena they are investigating before they dig into the learning helps them retain more knowledge and develop the skills and disposition of a scientist and a learned citizen.

Wonder starts off every concept by igniting natural curiosity with relatable content that inspires students to ask the questions they want to explore about the inner workings of the world around us.

Learn helps students find answers to the questions posed in Wonder. Students explore, observe, predict, and investigate the phenomena of science through rich texts, Hands-On Investigations and experiments, and engaging interactive resources.

Share requires students to summarize their learning with their peers and teacher. Students develop solutions to real-world challenges and write scientific explanations that include their evidence-based reasoning.

Hands-On Learning: All Students as Experimental Scientists

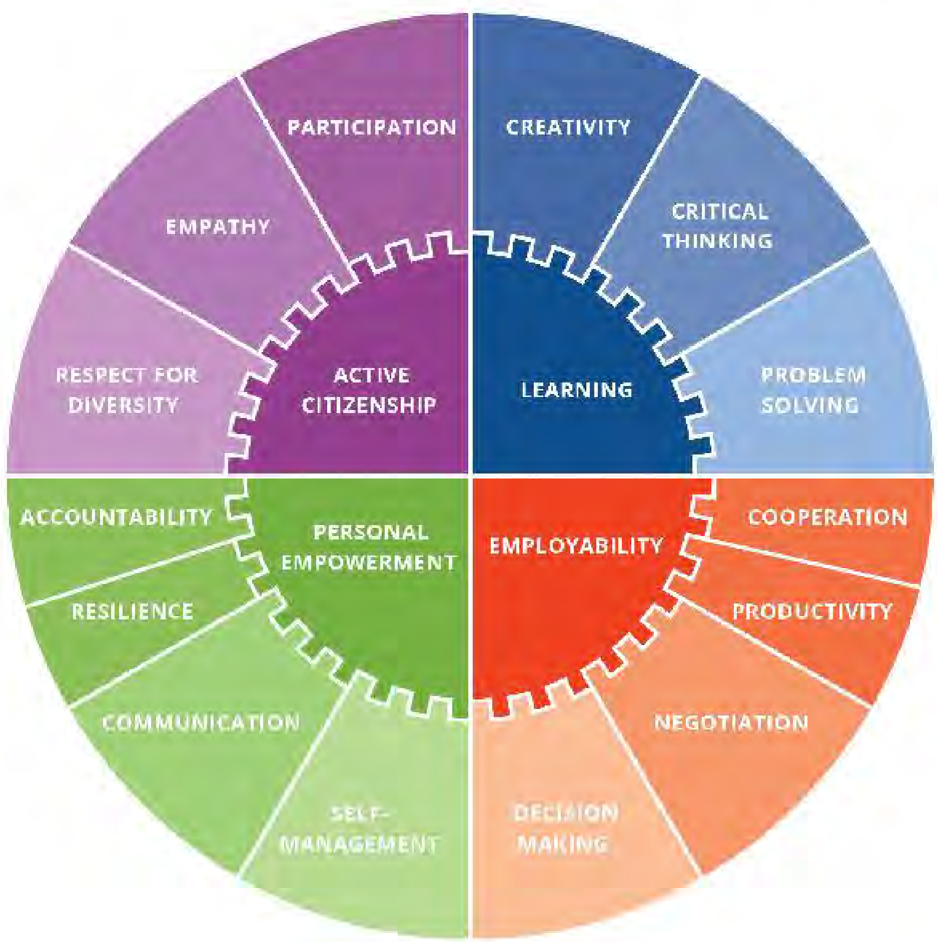
Hands-On Investigations (HOIs) are a foundational component of Primary 5 Science Techbook. Hands-On Investigations require students to investigate scientific ideas, build scientific understanding through observation, and practice the skills of doing science that develop their knowledge and effective solutions.

A materials list for each HOI is included in multiple locations: at point-of-use in digital, in the print Teacher Edition, and in the print Student Edition. Science materials were chosen to be easily accessible and mostly familiar to both students and teachers. Each materials list should be reviewed well in advance of the date of classroom use to ensure all materials are available. To assist teachers in familiarizing themselves with the HOIs, a series of teacher support instructional videos are included with this product.

Globally Prepared Students: Action-Packed, Real-World Challenges

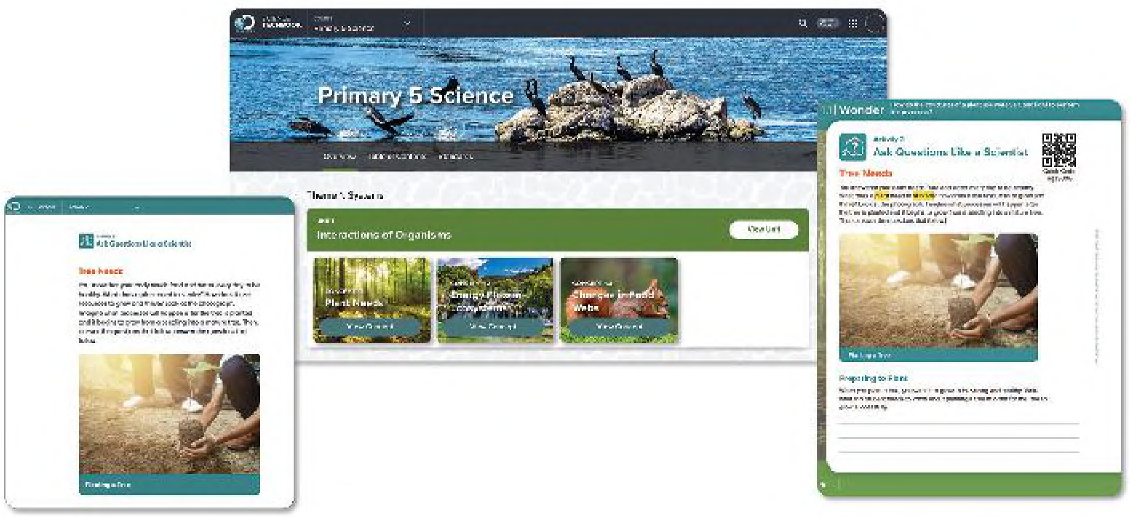
To prepare students with the skills they need to succeed in an interconnected, global society, Primary 5 Science Techbook integrates skills and concepts from career fields, technology, entrepreneurship, and life skills.

- **Careers:** The study of science, technology, engineering, and math (STEM) fields and pathways to STEM careers provides an ongoing emphasis on careers and real-world applications for learning.
- **Technology:** Students examine the structure and function of individual technologies as well as both the role of technology in society and the role of society in the development and use of technology.
- **Entrepreneurship:** In the Share portion of each concept, students encounter the skills of entrepreneurship, including discovering opportunities, generating creative ideas, setting a vision for transforming ideas into valuable activities, and using ethical and sustainable thinking.
- **Life Skills:** Building on introductions made through Primary 4, Primary 5 Science Techbook highlights opportunities to apply and practice the life skills throughout the instructional sequence.



Course Structure

The Primary 5 Science Techbook is a comprehensive teaching and learning package, featuring an easy-to-use digital platform, an interactive print Student Edition, and a print Teacher Edition. This print Teacher Edition provides guidance for teachers to implement high-quality, three-dimensional learning through Hands-On Investigations, lab investigations, and print and digital assets. This flexibility of resources supports the many variations of classroom settings, so teachers can implement standards-based lessons no matter their particular situation. The digital and print resources work seamlessly together, allowing students to both express thinking on paper and explore ideas and concepts digitally.



Themes

The Primary 5 Science Techbook is organized into four themes that form the structure of science courses from Primary 4 through Primary 6. In each grade, the theme is studied through an applied topic, represented by units within this curricular resource. Each unit launches with an engaging, real-world anchor phenomenon to captivate students. The anchor phenomenon will inspire students to ask questions they themselves want to investigate. At the end of the learning progression, students solve problems related to the anchor phenomenon with the culminating unit project. The themes and Primary 5 units are as follows:

Theme	Primary 5 Unit
Systems	Interactions of Organisms
Matter and Energy	Particles in Motion
Protecting Our Planet	Earth's Resources
Change and Stability	Patterns in the Sky

Concepts

Within each unit there are three concepts, which are the heart of the learning process. The concepts help students understand the anchor phenomena with the development of learning standards through the use of text, multimedia, Hands-On Investigations, and STEM projects. Every concept:

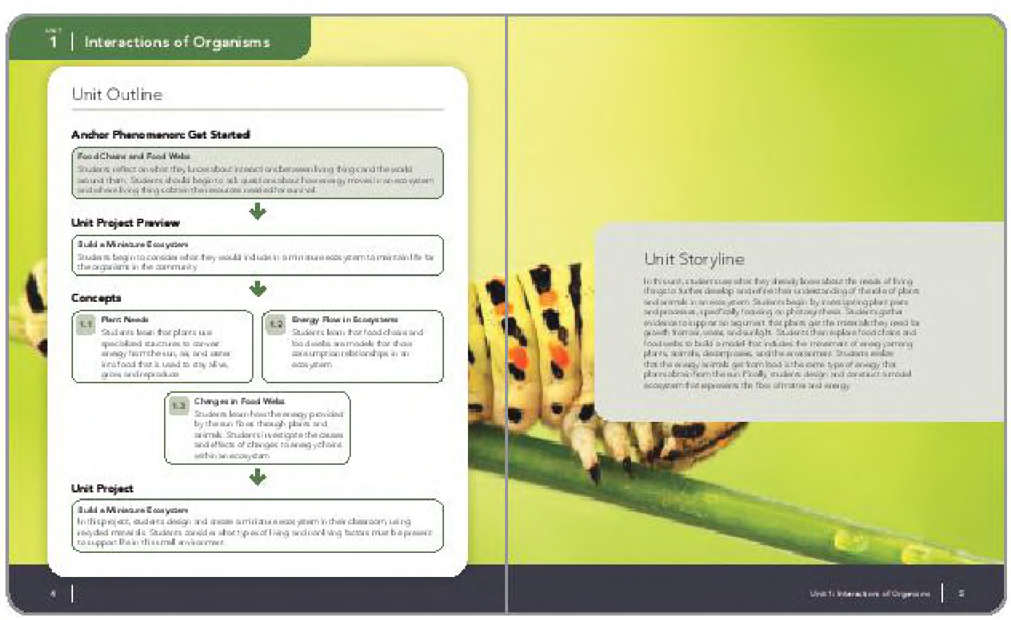
- launches with an investigative phenomenon and a related Can You Explain? question;
- provides multiple pathways for students to demonstrate their learning, including the creation of scientific explanations in the claim, evidence, reasoning format;
- includes digital extension activities designed to deepen understanding using digital tools or additional material;
- encourages STEM career exploration; and
- helps students summarize their understanding through a required unit project.

Activities

Each concept is comprised of a series of activities or learning experiences. The Recommended Pathway clearly outlines the sequence and duration of each learning activity. Activities vary in length and many daily lessons include several activities that are woven together to create rigorous learning experiences for students.

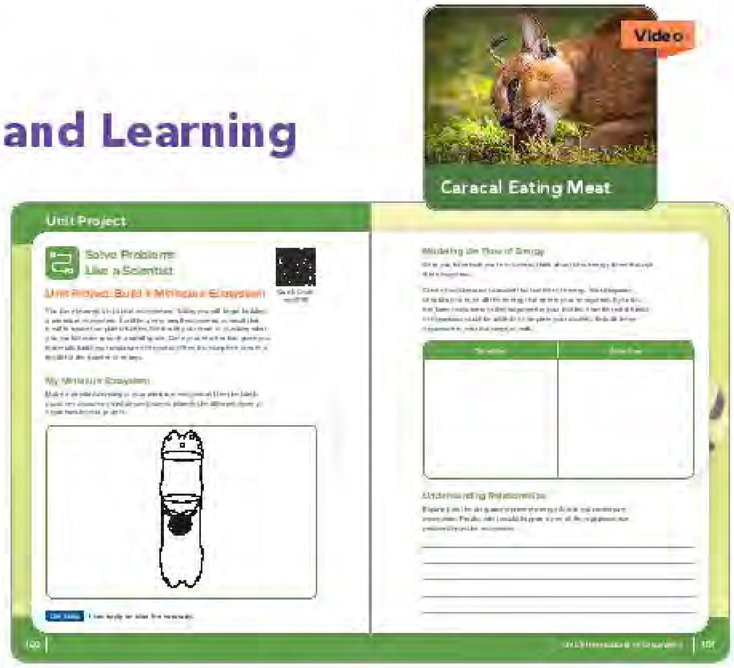
Unit and Concept Overviews

Each unit in the Teacher Edition begins with a storyline. The storyline summarizes the big picture of how the unit anchor phenomena, supporting concepts, and culminating unit projects interact with and build on one another. Each concept provides pacing directions, differentiation, and STEM and entrepreneurship connections.



Approach

Using Phenomena to Spark Curiosity and Learning



Throughout this course, real-world and engaging phenomena are used to pique students' curiosity.

This phenomenon-based instructional approach shifts the focus from learning about a topic to uncovering why or how a scientific event happened. At the unit level, an anchor phenomenon sets a purpose for learning across concepts. A unit project, highlighted at the beginning of each unit, expects students to return to the anchor phenomenon at the end of the unit. The unit project summarizes student learning across the unit storyline and serves as a summative assessment of three-dimensional learning.

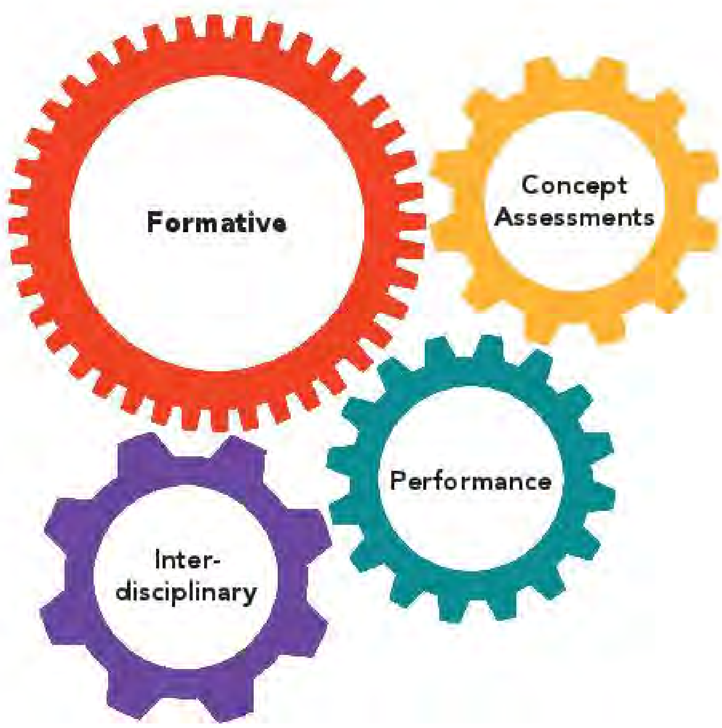
Each concept also begins with a smaller, real-world investigative phenomenon to inspire students to uncover the scientific principles behind the phenomenon. Students dive into the remainder of the content using a variety of scientific practices, including asking questions, observing, analyzing information, and designing solutions. Students return to the investigative phenomenon at the end of each concept, using the scientific skills and practices to provide evidence and reasoning for their claims.

Approach to Assessment

Assessments are an integral part of instruction that provide evidence of proficiency and student success. By using a variety of assessment formats and data sources, a comprehensive program can serve three distinct functions:

- Monitor students' progress and provide feedback to promote student learning
- Make instructional decisions to modify teaching to facilitate student learning
- Evaluate students' achievement to summarize and report students' demonstrated understanding at a particular point in time

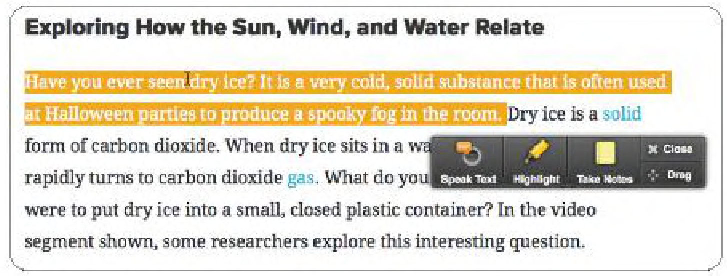
In the Primary 5 Science Techbook, assessments are embedded throughout as formative, summative, performance-based (project-based), and interdisciplinary projects.



Science Techbook Features

Tools and Text Features

The tools within every concept in Primary 5 Science Techbook support differentiation for the core instructional activities and cater to the different learning preferences of diverse learners. In the digital core interactive text, students and teachers can have text read aloud, highlight important information, or annotate content with sticky notes. Select the text in any concept, and a reader tool will appear.



Digital Teacher Materials

In digital Primary 5 Science Techbook, teachers can not only easily see the student view of content, but they can also access additional support using the Teacher Presentation Mode toggle. Teacher notes, featuring instructional purpose, scientific context, and recommended strategy, are included with each activity and are visible to teachers only. In addition, teachers can view sample responses to student questions, and Hands-On Investigations include a teacher's guide with detailed procedural notes.

Flexible Learning Environment

With the evolution of technology, today's students expect information to be available differently than previous generations. Students are accessing information in shorter segments, streaming digital shows, and reading posts through social media. The Primary 5 Science Techbook taps into students' preferences of consuming digital content and provides highly engaging, standards-based content guaranteed to inspire and encourage students to delve deeper into science.

Through every step of the learning cycle, the Primary 5 Science Techbook features diverse and rich multimedia resources: video, images, audio, interactives, virtual labs, online models, animations, rich informational text, and more. Engaging science content blends entertainment with education to motivate students to investigate real-world phenomena. Virtual labs and online models allow students to quickly manipulate variables to test their ideas in an online environment.

The Primary 5 Science Techbook includes a new element designed to enrich and enhance instruction: Digital Extension Activities. These activities are found in the online version of the program only, and can be assigned to students. The additional content can be used to reinforce and provide support for struggling students. Alternatively, if students are advanced, they may benefit from this extended content.

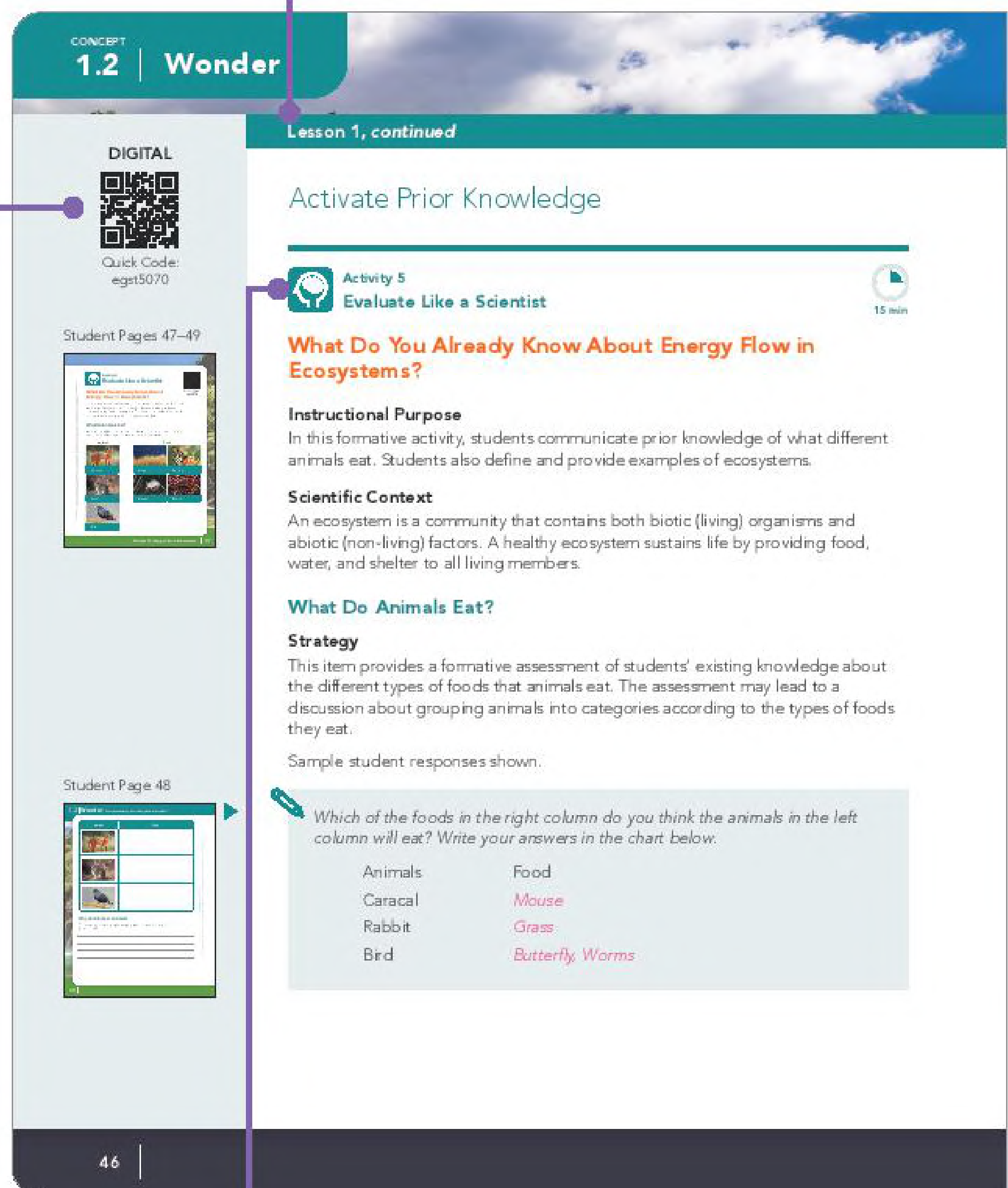
Concept Daily Instruction Features

Lessons

Instruction is presented in 45-minute segments by lesson.

Quick Digital Access

Throughout the print Student and Teacher Editions, QR codes and short links indicate opportunities to go digital to deepen learning through rich media or assessment opportunities.


CONCEPT 1.2 | Wonder

Lesson 1, *continued*

DIGITAL

Quick Code: egst5070

Student Pages 47–49

Student Page 48

Activate Prior Knowledge

Activity 5
Evaluate Like a Scientist

15 min

What Do You Already Know About Energy Flow in Ecosystems?

Instructional Purpose

In this formative activity, students communicate prior knowledge of what different animals eat. Students also define and provide examples of ecosystems.

Scientific Context

An ecosystem is a community that contains both biotic (living) organisms and abiotic (non-living) factors. A healthy ecosystem sustains life by providing food, water, and shelter to all living members.

What Do Animals Eat?

Strategy

This item provides a formative assessment of students' existing knowledge about the different types of foods that animals eat. The assessment may lead to a discussion about grouping animals into categories according to the types of foods they eat.

Sample student responses shown.

Which of the foods in the right column do you think the animals in the left column will eat? Write your answers in the chart below.

Animals	Food
Caracal	*Mouse*
Rabbit	*Grass*
Bird	*Butterfly, Worms*

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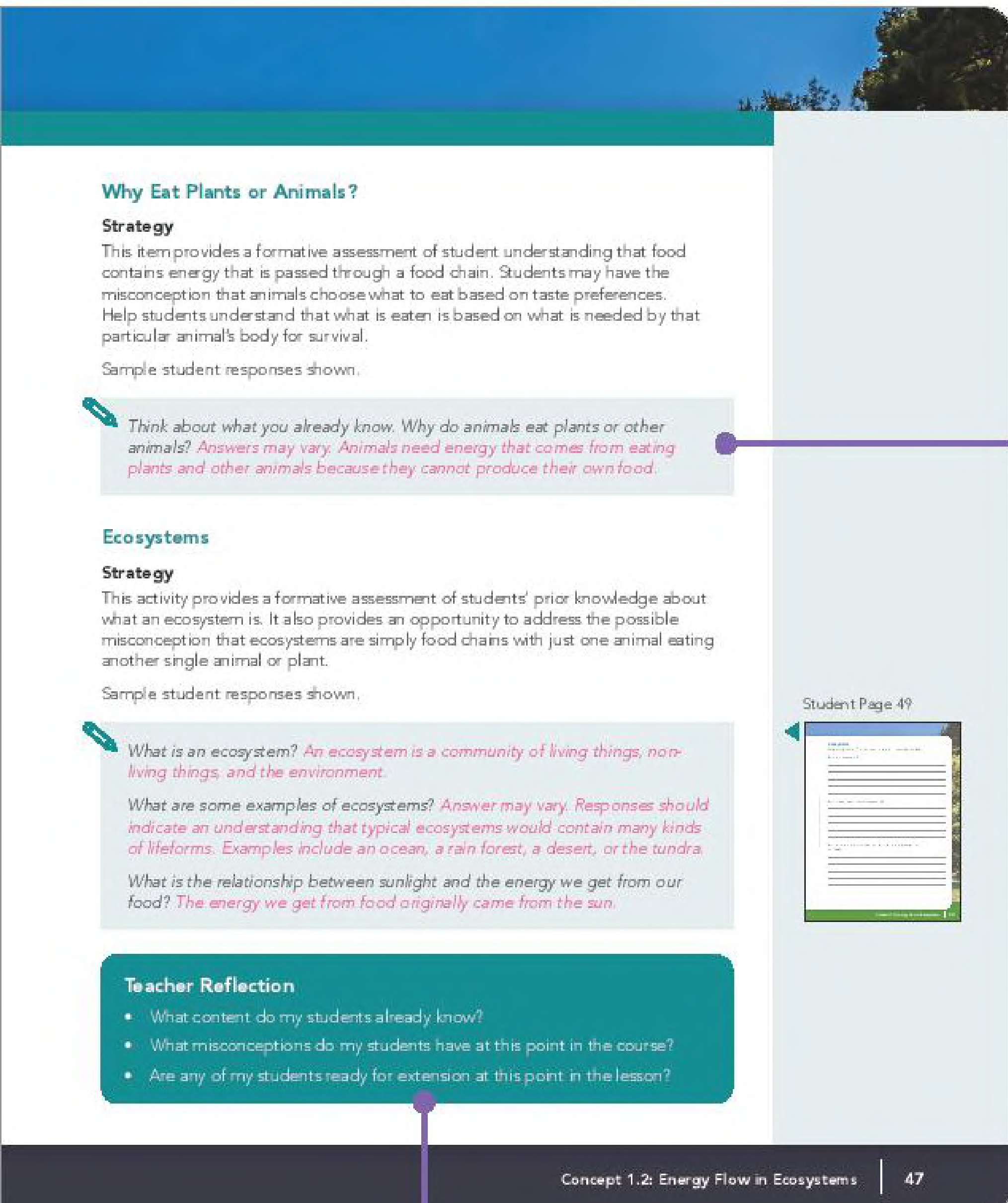
Activities

Within each day, strategies for a variety of activity types guide teachers through possible means of classroom implementation.



Why Eat Plants or Animals?

Strategy

This item provides a formative assessment of student understanding that food contains energy that is passed through a food chain. Students may have the misconception that animals choose what to eat based on taste preferences. Help students understand that what is eaten is based on what is needed by that particular animal's body for survival.

Sample student responses shown.

Think about what you already know. Why do animals eat plants or other animals? Answers may vary. Animals need energy that comes from eating plants and other animals because they cannot produce their own food.

Ecosystems

Strategy

This activity provides a formative assessment of students' prior knowledge about what an ecosystem is. It also provides an opportunity to address the possible misconception that ecosystems are simply food chains with just one animal eating another single animal or plant.

Sample student responses shown.

What is an ecosystem? An ecosystem is a community of living things, non-living things, and the environment.

What are some examples of ecosystems? Answer may vary. Responses should indicate an understanding that typical ecosystems would contain many kinds of lifeforms. Examples include an ocean, a rain forest, a desert, or the tundra.

What is the relationship between sunlight and the energy we get from our food? The energy we get from food originally came from the sun.

Student Page 49

Teacher Reflection

- What content do my students already know?
- What misconceptions do my students have at this point in the course?
- Are any of my students ready for extension at this point in the lesson?

Concept 1.2: Energy Flow in Ecosystems | 47

Student Response

The pencil icon indicates opportunities for students to respond in written or digital student materials. Sample responses are provided for easy review by teachers.

Teacher Reflection

Throughout each concept, questions encourage teachers to consider how activities are working in their classrooms and how well students are accessing the material.

Globally Prepared Students: Making Connections to Entrepreneurship and Real-World Problems

Preparing students in Egypt to be globally competitive is a major focus of Education 2.0. Solving many of the challenges facing our world today and tomorrow will require integrating skills and knowledge from science, technology, engineering, and math, as well as core life skills. The Primary 5 Science Techbook introduces age-appropriate examples of these challenges that align to Egyptian Issues such as citizenship, globalization, and the environment and development. STEM applications are highlighted throughout this course in Share activities, Unit Projects, and the Interdisciplinary Projects.

Share Activities

At the end of each concept, students synthesize learning in a series of Share activities. Students construct scientific explanations related to the opening Can You Explain? question (or other student-generated questions from Wonder). Students consider real-world applications by exploring career and entrepreneurship connections. And finally, students summarize learning by thinking about, writing about, and reviewing connections to the big ideas of the unit.

ENTREPRENEURSHIP

Chefs in restaurants or even home chefs are often some of the most creative entrepreneurs. Chefs manage a variety of resources, from ingredients to cooking tools to personnel (if they own a restaurant or manage a staff). Encourage students to think of ways chefs must display leadership and set goals to stay motivated.

Interdisciplinary Projects: Content and Real-World Connections

As with the Primary 4 Science Techbook, Primary 5 includes the Interdisciplinary Projects, provided for students once per term. These Interdisciplinary Projects are based on real-world challenges derived from the United Nations Sustainable Development Goals. Countries across the globe adopted these Sustainable Development Goals in 2015 (with annual monitoring and tracking) to "end poverty, protect the planet, and ensure that by 2030, all people enjoy peace and prosperity.[1]"

For students to authentically connect academic content, practice life skills, and deeply understand the Egyptian Issues, we must provide opportunities for students to search for their own solutions. The Interdisciplinary Projects allow students to do just that. Students are presented with a challenge and then given the opportunity to generate ideas using knowledge and skills from science, mathematics, and other disciplines. Students work with classmates to design a solution to build, test, and refine using the Engineering Design Process.

The Interdisciplinary Project for Term 1, "Waste Not, Want Not," challenges students to repurpose plastic waste in an effort to protect our environment from excessive plastic waste. Students have previously studied the effects of plastic waste on coral reefs and other water-based ecosystems. Students are provided with background on a specific effort in the Red Sea to reduce plastic waste pollution. Students then work together to creatively repurpose waste to eliminate plastic products from entering waterways.

[1] "Sustainable Development Goals: United Nations Development Programme." UNDP, https://www.undp.org/sustainable-development-goals.

The Writing Process and Science Connection

Writing is an important part of science because it is how real scientists document and communicate their ideas, activities, and findings to others. Primary 5 Science Techbook engages students in many kinds of writing, especially argumentation. Argumentative writing in science calls for the use of evidence, often requiring students to read across several texts, watch videos and other media, and integrate findings from Hands-On Investigations.

Informational texts throughout Techbook help students strengthen their reading comprehension skills and develop both academic and discipline-specific language, while multimedia resources provide context and assist students in accessing the text. Primary 5 Science Techbook also authentically incorporates the writing process and expects students to use speaking and listening skills to demonstrate their understanding of science.

During the Share portion of each concept, students are asked to integrate their ideas in writing. Students should be familiar with using evidence to support a claim from their studies in Primary 4 Science. In Primary 5, students first make a claim, provide evidence and then construct a scientific explanation with reasoning. The higher level literacy skills involved in this type of writing include analysis, synthesis and evaluation. Students analyze the content studied in each concept. They then synthesize content and experiences, such as Hands-On Investigations, to formulate an explanation that evaluates the students' claim.

Teacher Reflection: How are you developing your students into scientific readers?

Teacher Reflection

- Did this activity engage the students?
- Did this activity allow students to generate their own questions?
- Would I organize this differently next year?

Building Academic Language of All Students

Reading and writing success in science depends on the ability of students to understand not only the definition of vocabulary words, but also how the academic language connects ideas, adds details, or organizes the text. Academic language is supported and emphasized through strategies for learning vocabulary, frequent vocabulary use in various texts, and formative assessment items.

Differentiated Instruction

Primary 5 Science Techbook allows teachers to differentiate instruction, degrees of readiness, and interests. Techbook also offers resources to help vary content, process, product, and learning environment through the core instructional pathway. Point-of-use teacher notes are integrated to support approaching and advanced learners.

Built upon the principles of Universal Design for Learning, Primary 5 Science Techbook features a variety of content types, including images, video, audio, text, interactives, and Hands-On Investigations. These multimedia resources, included in both digital and print, provide multiple representations of the content and the flexibility for teachers to assign targeted content to whole groups or individual students.

DIFFERENTIATION

Approaching Learners

For students who do not seem to have much experience with the scientific needs of plants, allow them to participate in other ways. For example, ask students to share what kinds of plants they see on their way to and from school, or ask them to share experiences they have had with caring for or observing others care for plants. Connect students' concrete, real-world experiences with the more scientific descriptions that are being introduced in this activity.

Primary 5 Science Scope and Sequence

Primary 5 • THEME	1	2	3	4
SCIENCE				
A. Skills and Processes				
1. Demonstrate thinking and acting inherent in the practice of science.				
a. Ask testable questions based on observations and predict reasonable outcomes based on patterns.	•	•	•	•
b. Plan and carry out investigations to collaboratively produce and collect data that answers a question.	•	•	•	•
c. Organize simple data sets to reveal patterns that suggest relationships.	•	•	•	•
d. Construct an argument with evidence and data.	•	•	•	•
e. Identify limitations of models.	•	•	•	•
f. Use multiple sources to answer questions or explain phenomena.	•	•	•	•
g. Communicate scientific information orally and in written formats.	•	•	•	•
B. Earth and Space Science				
1. Use scientific skills and processes to explain the chemical and physical interactions of the environment, Earth, and the universe that occur over time.				
a. Collect and use data to graph patterns in natural phenomena (such as daily changes in length and direction of shadows, day and night, the seasonal appearance of some stars in the night sky, and the tidal phenomenon). 1) Explain how the movements of the sun, Earth, and the moon produce these phenomena. 2) Identify the role of satellites in collecting data related to natural phenomena.				•

	1	2	3	4
b. Develop a model that positions Earth as it relates to the solar system. A model includes: 1) Distinguishing the components of the solar system (such as stars, planets, and moons). 2) Comparing the sizes of planets in the solar system (scaling sizes not included). 3) Arranging the planets according to their distance from the sun (scaling distances not included). 4) Describing the rotation of planets and their revolution around the sun.				•
c. Visually model or represent the distribution of water on Earth (including total water and fresh water in various reservoirs).			•	
d. Provide evidence of how living organisms, the water cycle, the atmosphere, and rocks and landforms function and interact as systems to support life on Earth. *[Examples could include how the ocean supports ecosystems on land or how mountain ranges affect winds and clouds in the atmosphere. Students are only responsible for describing the interactions of two spheres (systems) at a time.]*			•	
C. Life Science				
1. Use scientific skills to describe the essential needs of a living organism (plants and animals, including humans).				
a. Support an argument that plants get the materials they need for growth chiefly from air, water, and soil (where applicable). 1) Provide evidence of transport in plants through investigation. 2) Illustrate the function of the root and stem (as well as xylem and phloem vessels when applicable) in transporting air, water, and nutrients in plants. 3) Explain the process of photosynthesis as how a plant produces its own food for energy from light (this does not include the chemical reaction at the cellular level).	•			
b. Propose ways to maintain the health and safety of the cardiovascular system. 1) Explain the structure and function of the circulatory system in humans. 2) Analyze the relationship between level of activity and indicators of heart health.	•			

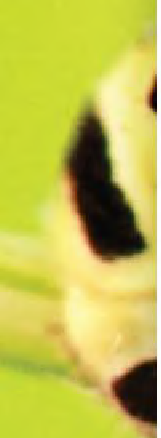
Primary 5 • THEME	1	2	3	4
D. Physical Science				
1. Use scientific skills and process to explain the interactions of matter and energy and the energy transformations that occur.				
a. Develop a model to describe that matter is made of particles too small to be seen. *[Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating saltwater, not to be explained using atomic theory.]* 1) Describe the characteristics of a solid, liquid, and gas in terms of how the particles interact. 2) Compare the properties of solids, liquids, and gases (such as volume, shape, or mass). 3) Explain the role of increasing or decreasing heat on the states of matter.		•		
b. Make observations and measurements to identify materials based on their properties. *[Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.]* 1) Classify materials based on physical properties, including shape, color, texture, or hardness, as well as physical state (solid, liquid, or gas). 2) Use appropriate tools to measure various properties (such as length, mass, or volume).		•		
c. Provide evidence through investigation of the effects of balanced and unbalanced forces on the motion of an object (such as starting and stopping, changing speed, or changing movement direction).				•
d. Support an argument that the gravitational force exerted by Earth on objects is directed down. 1) Describe patterns in objects experiencing gravitational force on small scales (such as falling down). 2) Conduct an investigation to produce data to show evidence of the effects of gravity on different objects. 3) Explain the relationship between the force of gravity and weight. 4) Differentiate between weight and mass.				•

	1	2	3	4
E. Environmental Science				
1. Use scientific skills and process to explain the interactions of environmental factors (living and nonliving and analyze their impact on a local and global scale.				
a. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. 1) Trace energy changes through a food chain. 2) Identify roles of producers, consumers, predators, prey, and decomposers in an ecosystem. 3) Illustrate the relationship between a food chain and a food web.	•			
b. Use diagrams to illustrate that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun. 1) Identify the sun as the source of energy in food chains. 2) Explain the relationship between the sun's energy and producers in a food chain or web.	•			
c. Determine the effects of resource availability on organisms and populations of organisms in an ecosystem.	•			
d. Generate an argument supported by evidence that changes to physical or biological components of an ecosystem affect populations.	•		•	
e. Predict and explain some patterns of interactions among living organisms (such as seed dispersal or pollination).	•			
f. Propose ways individual communities use science ideas to protect Earth's resources and environment (such as protecting air quality and soil or water conservation).			•	
F. Engineering Design and Process				
1. Apply engineering design processes and understanding of the nature and characteristics of technology to solve problems.				
e. Generate and compare multiple solutions to problems based on how well they meet the criteria and constraints.		•		
f. Assess the impact of products and systems.		•		

UNIT 1 | Interactions of Organisms

Theme 1 | Systems

Unit 1
Interactions of Organisms



Learning Indicators

Throughout this unit, students will work toward the following learning indicators:

Primary 5 • CONCEPT	1.1	1.2	1.3
SCIENCE			
A. Skills and Processes			
1. Demonstrate thinking and acting inherent in the practice of science.			
a. Identify scientific and non-scientific questions.	●	●	●
b. Plan and carry out simple investigations to collaboratively produce and collect data that answers a question.	●	●	●
c. Organize simple data sets to reveal patterns that suggest relationships.	●	●	●
d. Construct an argument with evidence and data.	●	●	●
e. Identify limitations of models.	●	●	●
f. Use multiple sources to answer questions or explain phenomena.	●	●	●
g. Communicate scientific information orally and in written formats.	●	●	●
C. Life Science			
1. Use scientific skills to describe the essential needs of a living organism (plants and animals, including humans).			
a. Support an argument that plants get the materials they need for growth chiefly from air, water, and soil (where applicable). 1) Provide evidence of transport in plants through investigation. 2) Illustrate the function of the root and stem (as well as xylem and phloem vessels when applicable) in transporting air, water, and nutrients in plants. 3) Explain the process of photosynthesis as how a plant produces its own food for energy from light (this does not include the chemical reaction at the cellular level).	●		

	1.1	1.2	1.3
b. Propose ways to maintain the health and safety of the cardiovascular system. 1) Explain the structure and function of the circulatory system in humans. 2) Analyze the relationship between level of activity and indicators of heart health.	•		
E. Environmental Science			
1. Use scientific skills and processes to explain the interactions of environmental factors (living and nonliving) and analyze their impact on a local and global scale.			
a. Develop a model to describe the movement of matter among plants, animals, decomposers, and the environment. 1) Trace energy changes through a food chain. 2) Identify roles of producers, consumers, predators, prey, and decomposers in an ecosystem. 3) Illustrate the relationship between a food chain and a food web.		•	•
b. Use diagrams to illustrate that energy in animals' food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun. 1) Identify the sun as the source of energy in food chains. 2) Explain the relationship between the sun's energy and producers in a food chain or web.	•	•	•
c. Determine the effects of resource availability on organisms and populations of organisms in an ecosystem.			•
d. Generate an argument supported by evidence that changes to physical or biological components of an ecosystem affect populations.			•
e. Predict and explain some patterns of interactions among living organisms (such as seed dispersal or pollination).	•	•	•

Unit Outline

Anchor Phenomenon: Get Started

Food Chains and Food Webs
Students reflect on what they know about interactions between living things and the world around them. Students should begin to ask questions about how energy moves in an ecosystem and where living things obtain the resources needed for survival.

Unit Project Preview

Build a Miniature Ecosystem
Students begin to consider what they would include in a miniature ecosystem to maintain life for the organisms in the community.

Concepts

1.1 Plant Needs
Students learn that plants use specialized structures to convert energy from the sun, air, and water into food that is used to stay alive, grow, and reproduce.

1.2 Energy Flow in Ecosystems
Students learn that food chains and food webs are models that show consumption relationships in an ecosystem.

1.3 Changes in Food Webs
Students learn how the energy provided by the sun flows through plants and animals. Students investigate the causes and effects of changes to energy chains within an ecosystem.

Unit Project

Build a Miniature Ecosystem
In this project, students design and create a miniature ecosystem in their classroom, using recycled materials. Students consider what types of living and nonliving factors must be present to support life in this small environment.

Unit Storyline

In this unit, students use what they already know about the needs of living things to further develop and refine their understanding of the role of plants and animals in an ecosystem. Students begin by investigating plant parts and processes, specifically focusing on photosynthesis. Students gather evidence to support an argument that plants get the materials they need for growth from air, water, and sunlight. Students then explore food chains and food webs to build a model that includes the movement of energy among plants, animals, decomposers, and the environment. Students realize that the energy animals get from food is the same type of energy that plants obtain from the sun. Finally, students design and construct a model ecosystem that represents the flow of matter and energy.

Unit 1 Introduction: Get Started

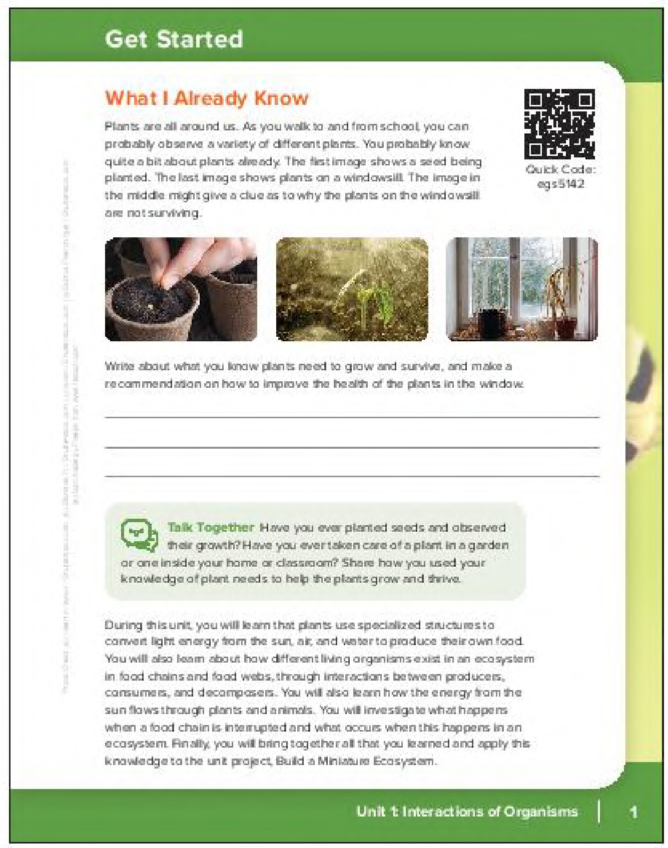
What I Already Know

Quick Code:
egst5142

The Primary 5 science curriculum starts each unit with an activity designed to activate students' prior knowledge. Unit 1 is focused on the flow of energy and matter in ecosystems. Students have previously studied the needs of living things, the basic parts of plants, and some interactions between plants, animals, and the environment. This unit goes deeper into specialized plant structures, the processes of photosynthesis, and how the energy from the sun travels through all living organisms in an ecosystem.

The unit opener What I Already Know includes images that should be familiar to students, focusing on plant needs. Before starting the activity, allow students to share experiences with taking care of plants at home or of gardening in the community. Ask students if they have been to a farm or seen larger-scale agriculture. Accept all responses and allow students to share a variety of experiences and ideas.

Ask students to carefully observe the image showing plants in a windowsill. What do students notice about the health of the plants? After allowing students to discuss, instruct them to complete the activity.


Get Started

What I Already Know

Plants are all around us. As you walk to and from school, you can probably observe a variety of different plants. You probably know quite a bit about plants already. The first image shows a seed being planted. The last image shows plants on a windowsill. The image in the middle might give a clue as to why the plants on the windowsill are not surviving.

Quick Code:
egs5142

Write about what you know plants need to grow and survive, and make a recommendation on how to improve the health of the plants in the window.

Talk Together Have you ever planted seeds and observed their growth? Have you ever taken care of a plant in a garden or one inside your home or classroom? Share how you used your knowledge of plant needs to help the plants grow and thrive.

During this unit, you will learn that plants use specialized structures to convert light energy from the sun, air, and water to produce their own food. You will also learn about how different living organisms exist in an ecosystem in food chains and food webs, through interactions between producers, consumers, and decomposers. You will also learn how the energy from the sun flows through plants and animals. You will investigate what happens when a food chain is interrupted and what occurs when this happens in an ecosystem. Finally, you will bring together all that you learned and apply this knowledge to the unit project, Build a Miniature Ecosystem.

Unit 1: Interactions of Organisms | 1

Sample student responses shown.

Write about what you know plants need to grow and survive, and make a recommendation on how to improve the health of the plants in the window.
Answers may vary. Plants need water, sunlight, space, and soil to grow. Watering the plants in the windowsill or providing new soil or new space/containers may improve the plants' health.

Anchor Phenomenon: Food Chains and Food Webs

Caracal Eating Meat

Shift the class discussion from the What I Already Know activity to examine the image shown, watch the video, and read the provided text for the Anchor Phenomenon Food Chains and Food Webs. While students may not be specifically familiar with a hyrax, most students will be able to name some animals from their local environment and will be able to discuss what they eat. Encourage students to share what they know about how animals find food and interact with their environment. Ask students to consider what elements make up the living and nonliving components of natural communities, known as ecosystems.

Unit Project Preview

Build a Miniature Ecosystem

Quick Code: egst5143

Students have investigated relationships and interdependence in ecosystems. Students now understand the different types of organisms and the roles that each living thing plays in sustaining life in the community. Students have also considered the importance of nonliving components in an ecosystem. Building a miniature ecosystem allows students to follow the transfer of energy, as well as observe changes that can occur in an ecosystem.

Question

What are some of the nonliving things that are critical for survival in an ecosystem?

Photo Credit: dugdax / Shutterstock.com

CONCEPT

1.1 Plant Needs

Concept Objectives

By the end of this concept, *students* should be able to:

- Argue from evidence that plants use specialized structures to obtain the materials that they need to grow from sunlight, air, and water.
- Develop a model of how energy moves through plants.
- Develop a model plant processes that use natural resources to complete life processes.
- Compare the structure and function of the transport system in plants with the circulatory system in humans.

Quick Code:
egst5001

Key Vocabulary

arteries, circulatory system, digestive system, dispersal, germinate, glucose, nutrients, phloem, photosynthesis, plant, stem, stomata, survive, system, veins, vessels, xylem

Quick Code:
egst5002

Concept Pacing

Recommended Pathway

In order to meet the expectations of the standards, students must complete each activity within the recommended pathway.

Location	Days	Model Lesson	Time
Get Started		Get Started	10 min
Wonder	Lesson 1	Activity 1	5 min
		Activity 2	15 min
		Activity 5	15 min
Learn	Lesson 2	**Activity 6**	45 min
	Lesson 3	**Activity 7**	30 min
		Activity 8	15 min
	Lesson 4	Activity 9	15 min
		Activity 10	30 min
	Lesson 5	Activity 11	20 min
		Activity 13	15 min
		Activity 15	10 min
	Lesson 6	**Activity 16**	30 min
Share		Activity 17	15 min

Quick Code: egst5003

Bold activities are Hands-On Investigations.
A full list of materials required, along with any additional preparation, can be found online.

Content Background

Throughout primary school, students are exposed to the study of living things in various ways. As students learn about what organisms need to survive, the complexity of this material can be deepened at each stage. What students already know about the basic needs of plants is the starting point for a more sophisticated look at the structure of plants. In this first concept, students participate in more complex scientific investigations to build upon what they have likely learned in previous years about how plants rely on water and sunlight. Students then explore the specialized structures that turn raw materials into energy for a plant. Finally, students look at the process of energy production in plants and how energy is used for reproduction and seed dispersal.

Plant Structures

Plants need water and nutrients from the soil, carbon dioxide from the air, and light energy from the sun to survive. Specialized structures found in plants enable them to obtain the resources that they need, as well as manufacture the food needed for growth and reproduction. Plants absorb water and nutrients from the soil through their root systems. From there, the water and nutrients move through a network of tubes in the plant's stem or trunk to its leaves. Xylem tubes move water upward from the roots to the leaves, while phloem tubes carry food from the leaves to the rest of the plant. Plants with such tubes are called vascular plants. Water and nutrients move from cell to cell in plants that lack tubes, called nonvascular plants. Plant leaves absorb light energy and carbon dioxide from the air. Specialized structures in the leaves, chloroplasts, allow for the capture of energy from sunlight. Stomata, openings on the leaf, control the exchange of essential gases between the plant and the environment. The opening and closing of these structures also moderate water loss in the plant.

Photosynthesis

The cells of the leaves contain chlorophyll, which is a green pigment, within the chloroplasts. Chlorophyll uses the sun's energy to convert carbon dioxide and water into glucose, a sugar. This process is called photosynthesis. Plants use glucose as energy for growth and reproduction. The plant releases oxygen into the air as a waste product of photosynthesis. The carbon dioxide in the air that plants use during photosynthesis is a waste product that animals (including humans) release during breathing. Thus, plants depend on animals for carbon dioxide, and animals depend on plants for oxygen. Plants could not survive without animals, and animals could not survive without plants. It is important for students to understand the interdependence of plants and animals as they think about the basic needs of plants.

Video Lesson 1

Quick Code: egst5005

CONCEPT
1.1 | Wonder

Lesson 1

DIGITAL

Quick Code: egst5004

Student Page 5

Activity 1
Can You Explain?

5 min

How do the structures of a plant use water, air, and light to perform life processes?

Instructional Purpose

In this introductory activity, students communicate prior knowledge about how the structures of a plant use water, air, and light to perform life processes.

Scientific Context

The systems that plants use to sustain life and grow are, in some ways, both similar to and different from those in animals. Plants use structures that are unique among living things to produce their own food using sunlight.

Life Skills **Endurance**

Strategy

Encourage students to explain what they know about the basic needs of plants and how these needs are met. Challenge students to think about different plant structures. Next, think about how the structures function to help the plant survive.

Students may have some initial ideas about how to answer the question. Students should be able to construct a scientific explanation by the end of the concept. The explanation will include evidence from the concept activities.

ASK

- *Have you ever planted a seed and watched it grow into a plant? Think about what the plant needs to grow.*
  Answers may vary. Students should recall from previous learning that plants need water, soil, sunlight, and room to grow.
- *What is the structure of a plant?*
  Answers may vary slightly, but students should recall from previous learning that plants have roots, stem, and leaves.

Instruct students to record what they already know about how plants perform life processes. Allow time for individual responses prior to a brief classroom discussion.

Sample student responses shown.

How do the structures of a plant use water, air, and light to perform life processes? Answers may vary. Plants have roots, a stem, leaves and sometimes flowers or fruit. The roots help the plant get nutrients from the soil and water. The other parts help the plant survive.

DIGITAL

Quick Code:
egst5006

Student Pages 6–7

Investigative Phenomenon

Activity 2
Ask Questions Like a Scientist

15 min

Tree Needs

Instructional Purpose

The Investigative Phenomenon is designed to ignite student curiosity about events in the world around them. In this activity, students will begin to connect the growth of a plant with the scientific processes that unfold as a plant uses resources to meet its basic needs.

Scientific Context

Students may have cared for a plant before and may already have some understanding that plants need water, sunlight, space, and air to grow. However, students may not have considered which structures make it possible for a plant to use resources to complete life processes.

Preparing to Plant

Strategy

Show students the image Planting a Tree. Explain that the child in the photograph is planting a tree. Encourage students to think about what this person needs to know about planting a tree in order for the tree to grow successfully. Ask students to predict the tree's needs and record questions about how to plant the tree so it will grow successfully. If possible, display a potted plant to further stimulate ideas.

ASK

- *What should the child consider before planting the tree?*
  Answers may vary. Students will likely mention condition of the soil, availability of water and sunlight or space/room to grow.
- *Why does the plant need care?*
  Answers may vary.
- *What would happen to the plant if no one cared for it?*
  Answers may vary.
- *Do you have any questions about the needs of the plant?*
  Answers may vary.
- *How could you find the answers to your questions?*
  Answers may vary.

Sample student responses shown.

When you plant a tree, you want it to grow to be strong and healthy. Write what this student needs to know about planting a tree in order for the tree to grow successfully. Answers may vary. Encourage students to ask probing questions to further develop their initial thoughts. For example: Will the plant be tall? How much room will the plant need to grow?

Student responses to these and additional questions about plant survival will be addressed with the resources found in this concept.

My Model of a Plant

Strategy

Direct students to draw a model of a plant and depict how the plant meets its needs. This will activate prior knowledge about plants and their parts. Students should label all the known parts, including the function each part serves. Tell students that throughout the concept, the model will be revisited to add more details and make any needed corrections.

Sample student responses shown.

Draw a model of a plant and show how the plant meets its needs. Your model can be words, pictures, symbols, or any combination of these choices. Answers may vary.

After students have recorded their responses, lead a discussion to identify basic understandings of the needs of plants. This lesson will support students as they begin developing a model of plants as systems, identifying how plants live and grow, and summarizing the roles of larger systems of plants and animals on Earth.

Student Page 7

Digital Extension Activity 3
Observe Like a Scientist

10 min

Growing

Use this online extension activity to extend student exploration.

Quick Code: egst5007

Digital Extension Activity 4
Observe Like a Scientist

10 min

Water in the Desert

Use this online extension activity to extend student exploration.

Quick Code: egst5008

DIGITAL

Quick Code: egst5009

Student Pages 8–10

Activity 5
Evaluate Like a Scientist

15 min

What Do You Already Know About Plant Needs?

Instructional Purpose

This formative assessment asks students to consider similarities and differences between the needs of plants and animals. The activity will highlight misconceptions students may have prior to beginning activities in Learn.

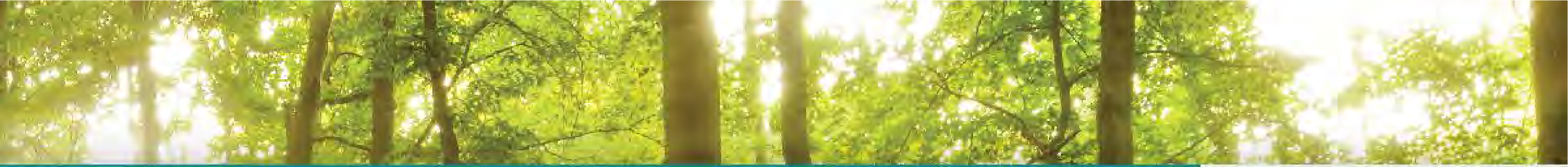
Scientific Context

Some needs of plants and animals are very similar while others are very different. For example, most animals move to find their own food, while plants create their food through photosynthesis. Animals need food, water, shelter, and oxygen for survival. Plants need nutrients, water, carbon dioxide, and sunlight.

Plants and Animals

Strategy

Plants and Animals gauges students' prior knowledge and can prompt a discussion about similarities and differences between the needs of plants and animals. It also highlights a potential misconception that students might have, that plants "eat" the way animals do. This item can be done individually or in pairs.



Sample student responses shown.

What do plants need to live and grow? Answers may vary. Students should list water, air, sunlight, and nutrients from soil as basic needs.

How are the needs of plants similar to those of humans? Answers may vary. Students should list water and air as basic needs of both plants and humans.

How are the needs different? Answers may vary. Humans and other animals need to eat food to gain energy and nutrients to live and grow. Most plants get nutrients from soil and make their own food through photosynthesis in their leaves.

Plant Needs

Strategy

Plant Needs gauges students' basic prior knowledge about the needs of plants. It can also help you identify several shared common misconceptions.

- Students may think that plants need only oxygen when, in fact, they need carbon dioxide and produce oxygen (some of which they may use for respiration).
- Students may think that all plants require soil. While many plants do need soil for sustained growth, some do not.
- Some students, thinking of syrup coming from the sap of trees, may mistakenly believe that plants need sugar. As a class, discuss these misconceptions.

Sample student responses shown.

Think about what plants need to live and grow. Label each item listed as "Basic Plant Need" or "Not Basic Plant Need."

Water: *Basic Plant Need*

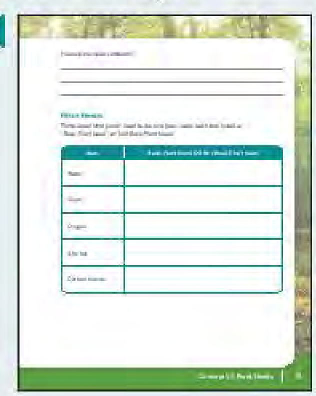
Sugar: *Not Basic Plant Need*

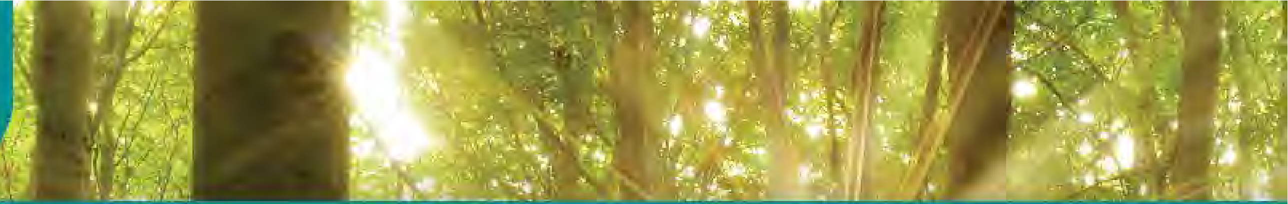
Oxygen: *Basic Plant Need*

A forest: *Not Basic Plant Need*

Carbon dioxide: *Basic Plant Need*

Student Page 9





Student Page 10

Sample student responses shown.

You may notice that soil was not listed in the previous table. Can you think of any reasons why soil may not have been included as a basic plant need? *Answers will vary. Some students may know of plants that only grow in the water. Some may also reference plants that seem to grow from the air or plants that grow on other plants instead of having roots in the soil.*

Plants and Food

Strategy

Plants and Food activates students' prior knowledge about how plants get their food. Answers can be listed on the board as students volunteer responses. This item highlights a common misconception that plants get their food from the soil. At this point, some students may understand that plants make their own food, but students may not know that food production happens in the leaves. Students may also be unfamiliar with the term *photosynthesis*. Use student answers to establish your understanding of their prior knowledge. This is also an opportunity to suggest that students think about these answers and revisit them after completing the Learn activities in this concept.

Sample student responses shown.

How do plants get their food? *Plants make their own food—a type of sugar—in their leaves by means of photosynthesis. This sugar provides energy for plant growth.*

How do the roots, stems, and leaves each help the plant get food? *The roots of a plant absorb water and nutrients from the soil. These are carried from the roots to the leaves through the stem.*

DIFFERENTIATION

Approaching Learners

For students who do not seem to have much experience with the scientific needs of plants, allow them to participate in other ways. For example, ask students to share what kinds of plants they see on their way to and from school, or ask them to share experiences they have had with caring for or observing others care for plants. Connect students' concrete, real-world experiences with the more scientific descriptions that are being introduced in this activity.

Video Lesson 2

Quick Code: egst5010

Activity 6
Investigate Like a Scientist

45 min

Hands-On Investigation: Do Plants Need Soil?

Instructional Purpose

In this activity, students determine whether plants need soil to grow by germinating bean seeds in wet paper towels, measuring the growth of these seeds, and comparing the results to the growth of a control seed germinated in soil.

NOTE: Students may recall prior learning experiences in which bean seeds were germinated in wet paper towels. If so, tell students that in this investigation, different seeds will be used, and variables will be added.

Scientific Context

In this activity, students focus on adding to or refining their model of what a plant needs to grow and survive. Carrying out the processes of gathering evidence, constructing arguments, and revisiting previous work are all important scientific skills that students will call upon as they engage in more complex experiments later.

Life Skills Critical Thinking

Activity Activator: Make a Prediction

Probe students' existing ideas about the role of soil in plant growth by asking for evidence that supports or refutes the following claim: *Plants can grow without soil.* Facilitate discussion and record students' predictions and reasoning for future reference. Encourage students to investigate claims with this Hands-On Investigation.

As students think of questions during the investigation, post the questions on a class question board. Each day, return to the board to see if any questions can be answered.

To introduce the activity, ask students what plants need to grow. (Answers should include water, soil, air, and sunlight.) Then, ask if plants can grow without one of those things, and if so, which one it would be. Ask what the advantages and disadvantages of growing plants in water could be. Then, tell students the claim will be tested by germinating seeds both in and out of soil. If necessary, explain that the word *germinating* means sprouting seeds.

Students will test the variable of growing a seed in water compared to the control test of growing a seed in soil. Discuss the difference between a control and a variable group. Once students understand the difference, ask what data would be collected to compare the growth of the two groups. After the investigation concludes and students have collected and analyzed the data, explain the concept of hydroponics, or growing plants in water.

DIGITAL

Quick Code: egst5011

Student Pages 11–14

Materials List
(per group)

- Plastic cup, 250 mL
- Soil, potting
- Paper towels
- Seeds, fava or other beans
- Plastic zipper bags
- Water
- Pen or marker
- Metric ruler
- Lettuce or similar small plants (optional)

Lesson 2, *continued*

Sample student responses shown.

Consider the claim: Plants can grow without soil. *Do you agree or disagree? Record your ideas and make a prediction about what will happen when we compare how plants grow with and without soil. Be sure to include reasoning for your prediction.*

My prediction and reasoning: *Answers may vary. Sample responses should include ideas about the importance of soil versus the other needs of plants to grow and survive. Students may reference past experiences or observations in their responses.*

Safety

- Follow all lab safety guidelines.
- Follow proper disposal and cleaning procedures after the lab.
- Clean up any spills immediately

Activity Procedure: What Will You Do?

Distribute one cup filled with water and another with potting soil to each group, along with the other materials.

1. Direct students to wet the paper towel with the water in the cup. Students should make certain the paper towel is thoroughly saturated with water but is not dripping.
2. Ask students to place three bean seeds on the top half of the paper towel. Next, students fold the bottom half of the towel up so that it covers the seeds. The paper towels are then placed and sealed inside the plastic zipper bag.
3. Guide students to plant three bean seeds in the cup of soil. Ask students what else is needed to grow plants in soil. Direct students to water the seeds with some of the remaining water.
4. Instruct students to label the plastic bag and soil cup with their names, and then place both the plastic zipper bag and the soil cup in a place with sunlight. Have students clean up any water or soil that may have spilled in the workplace.
5. Ask students to identify the control and variable in the investigation. Discuss as needed.
6. Guide students to use the provided data table to record test results. Ask students to determine what should be measured and how often. List ideas on the board. Each student group should determine how best to record data.
7. Over the next several days, have students check the growth of the seeds. Ask students when the paper towel should be dampened and the soil watered. Ask students to determine how to record addition of water and the amount on the data sheet.

8. Remind students that it may take a few days for the seeds to germinate and that each seed will grow at its own rate. Instruct students to measure the growth of each seed and to record its measurements, labeled by the date, and whether the seed being measured is germinating in the towel or in the soil cup.

Sample student responses shown.

Use the provided table to record your data. Measure the growth of each seed and record the measurements. Be sure to record the date of your observations and the location of the seeds, in the cup or the bag. *Answers may vary.*

Student Page 13

Alternate Procedure or Class Demonstration

1. Supply students with two lettuce plants (or other similar, fast-growing plants) and record the measurements.
2. Plant one lettuce plant in a soil cup and place the other lettuce plant in a cup of water.
3. Over the next several days, guide students to measure the growth of both plants. Students should create a data table that includes information by the date.

Analysis and Conclusions: Think About the Activity

At the end of the investigation, discuss the advantages of growing plants in water. Ask students to think about what the investigation shows about what plants need to grow. Can plants be grown entirely without soil? How can the hydroponic system be used to grow plants successfully? Are there plants that grow naturally in water?

Allow time for students to respond in writing to the questions after small group and class discussions.

Lesson 2, *continued*

Student Page 14

Sample student responses shown.

How much did the seeds that were placed in the paper towels grow? How did they compare to the seeds planted in soil? Answers may vary. Observations may be that the initial growth of the seeds is similar to that of the control.

Did the growth of the seeds, both in soil and in paper towels, match your initial claim? If not, how was it different? Answers may vary. Students may have hypothesized that the seeds grown without soil would not grow as quickly as the control.

Based on your observations, do seeds need soil to grow? Can plants grow entirely without soil? If so, will they grow better in soil? Why? Answers may vary. Students should note that seeds can grow without soil if they have water and sun. Also, plants can grow without soil for a while, but eventually they either need soil or a replacement like a full hydroponic system that provides a source of nutrients.

Teacher Reflection

Before moving on to the next Hands-On Investigation, consider these questions:

- Did my students successfully validate their claims about what is needed for plant growth?
- For students who are still struggling, what other information might help before moving on to the next activity?

Video Lesson 3

Quick Code: egst5013

Activity 7

Investigate Like a Scientist

30 min

Hands-On Investigation: Sunlight: A Basic Need

Instructional Purpose

In this activity, students plan and carry out an investigation about the effects of light on plant growth and collect data to analyze and interpret later in the concept.

Scientific Context

Now that students understand the use of controls and variables in an investigation, they are asked to practice data management skills. These skills are transferable to any investigation and are critical to being able to engage in more sophisticated experiments later.

Life Skills **Self-Management**

Activity Activator: Make a Prediction

Share the video segment Photosynthesis. Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

1. Direct students to watch the video once, and then discuss the process of photosynthesis with a partner. Direct students to read the text passage explaining the process of photosynthesis, and to discuss any questions they have with a partner.
2. Show the video a second time, pausing for discussion and calling upon student volunteers to explain the video throughout. Be sure to answer any student questions from the text passage.
3. Show the video a third time, asking students to watch and silently reflect on the process individually.
4. Ask students to record a diagram of photosynthesis for future reference.
5. Record any remaining student questions in a common place for future exploration.

Assemble students into pairs. Provide each pair with two plastic cups, enough soil for planting, water, and fava seeds. Explain that students will investigate differences in how plants grow in the light and in the dark. Ask students to consider prior experiences and respond to the questions under Make a Prediction.

DIGITAL

Quick Code: egst5012

Student Pages 15–19

Materials List

(per group)

- Plastic cups, 250 mL, 2
- Seeds, fava or other beans
- Soil, potting
- Water
- Permanent marker, black

Safety

- Follow all lab safety guidelines.
- Follow proper disposal and cleaning procedures after the lab.
- Clean up any spills immediately

Lesson 3, *continued*

Student Pages 16–17

Sample student responses shown.

What do you predict will happen to the plant in the light? Answers may vary. I predict that the plant will grow well and be a dark green color in the light.

What do you predict will happen to the plant in the dark? Answers may vary. I predict that the plant will not grow as well in the dark as in the light.

Activity Procedure: What Will You Do?

Distribute materials to each pair of students. Students should use the permanent markers to write their names on the cups and label the cups A and B. Students should add soil to their cups. The bean seeds should be placed on the soil, one per cup, and covered with about 2 centimeters of soil. Sufficient and equal amounts of water should be added to each cup to moisten the soil. Tell students to place cup A where it will receive light and to place cup B in the dark.

Facilitate a group discussion about the importance of variables and controls in experiments. Discuss the importance of keeping all variables constant except what is being tested. Ask students to name the variables in this experiment and share how they will keep conditions the same for both plants, except the amount of sunlight being provided. Students should consider variables such as how much water they provide and the room temperature remaining roughly the same for each plant.

Ask students to work as partners to create a data table that charts the growth and color of the seedlings over time.

Student pairs should meet daily to compare their observations. Students should record questions that occur during the process. Once the observation charts have been completed, students should write a paragraph summarizing their observations and results. Lastly, each student will draw a conclusion about a plant's need for light.

Reconvene as a large group. Ask student pairs to share observations, results, and questions that occurred during the experiment. Encourage students to come to a consensus for a general statement about the basic need for sunlight in plants.

Student Page 18

Sample student responses shown.

Data Table for Plant Growth: *Sample student observations should include measurements of height, descriptions of color of the plants, and so on.*

Analysis and Conclusions: Think About the Activity

The items in Think About the Activity provide a formative assessment of the Hands-On Investigation: Sunlight: A Basic Need. Students can answer these questions individually or in a group. Students should make and submit sketches on a separate piece of paper. Students should then return to the plant model drawing completed in Wonder. Ask students to add any additional details and corrections that might be needed based on evidence collected up to this point in the concept.

Sample student responses shown.

Student Page 19

What are the basic needs of plants? Plants need light, water, air, and nutrients.

What happened to the plant in the light? Answers may vary. The plant in the light grew to be 6 cm tall with four leaves.

What happened to the plant in the dark? Answers may vary. The plant in the dark grew only 2 cm with two small leaves. It was not as dark and green as the plant in the light.

Explain why light is important to plant growth. Include sketches to support your conclusions. Answers may vary. Light is important because plants use light to make food. Our investigation showed that this is true. The plant without light hardly grew at all because it had less food. The plant with plenty of light grew tall and strong. It had more leaves, and it was a darker green color. (Student sketch should be included and should show the characteristics being referred to in the response.)

Demonstration Activity

The sunflower is a highly phototropic plant. The sunflower plant grows toward the sun and tracks the movement of the sun throughout the day. The flower continually changes its direction with the movement of the sun.

To demonstrate phototropism, place a sunflower plant in direct sunlight. Make observations throughout the day. Ask students to record the movement of the flower and any questions. Discuss what role phototropism plays in the health of a plant.

Lesson 3, *continued*

DIGITAL

Quick Code:
egst5014

Student Pages 20–21

Student Page 21

Activity 8
Analyze Like a Scientist

15 min

Plant Structure

Instructional Purpose

Detailed diagrams are important to understanding many scientific concepts. In this activity, students use a text to create a labeled diagram of a plant including different functions of each structure.

Scientific Context

The different parts of a plant work together in a system. The roots, stem, and leaves should be familiar to students. In this activity, vessels, also known as xylem, are introduced, along with stomata.

Strategy

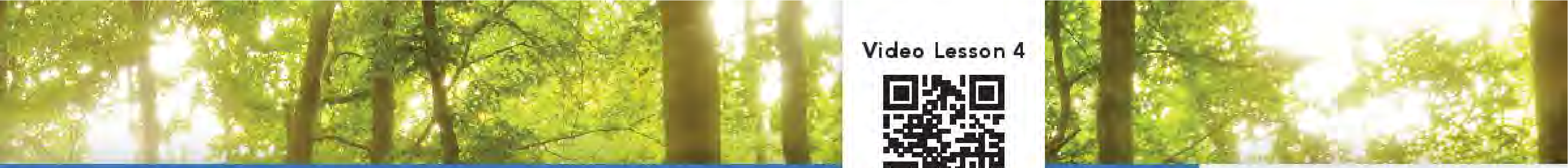
Assign students to read the text about plant needs and structures. Ask students to create a detailed diagram of a plant using the information from the text. Drawings should include a description of how each part functions to provide the plant with the materials it needs to grow.

ASK
- *How is reading an article like the work of a scientist?*
  Scientists must research work done by other scientists.
- *Why are detailed diagrams useful?*
  Answers may vary. Students may recall other diagrams they have used to learn more about structures or scientific concepts.

To help students be successful in this activity, reiterate that scientists study the relationships between structure and function to better understand the natural world. Students should be able to explain that obtaining information and recording evidence helps to study the relationships between plant structures and their functions.

Sample student responses shown.

Read the following text. As you read, draw the different plant parts in the box provided. Write about how the different plant structures function to help the plant survive. Students' drawings and descriptions will vary, but they should include roots, stem, leaves, vessels (xylem), and stomata.



Video Lesson 4

Quick Code: egst5016

DIGITAL

Quick Code: egst5015

Student Pages 22–23

Activity 9

Observe Like a Scientist

15 min

Parts of a Plant

Instructional Purpose

In this activity, students watch a video and read a text to obtain information about specialized plant parts that take up and transport water, nutrients, and air.

Scientific Context

Students gain additional details about plant parts and processes via research. The parts of a plant that assist with photosynthesis are outlined and explained.

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

Direct students to watch the video segment Parts of a Plant.

ASK

- *What are the key parts of the plant?*
  roots, stem, leaves, flower
- *How do the parts of the plant work together?*
  The parts of a plant work together to make food for the plant (photosynthesis).

Direct students to watch the video a second time. Allow time for students to record new information in the diagram and descriptions started during the previous activity. To help students deepen reasoning skills, ask probing questions such as: *Why do you think that? What is your evidence? How did you arrive at that conclusion?*

After watching the video, direct students to read the companion text. Again, allow time to revisit and add to or change the diagram and descriptions. Ask students to add to or modify their drawings to reflect new understanding. As a final step, students should share their diagrams and writing with a partner to clarify understanding.

Lesson 4, *continued*

DIGITAL

Quick Code:
egst5017

Student Pages 24–26

Materials List
(per group)

- Celery stalk
- White carnation flowers (optional)
- Plastic cups, 250 mL
- Food coloring
- Scissors
- Hand lens
- Water
- Knife (optional, for teacher use only)

Safety

- Follow all lab safety guidelines.
- Follow proper disposal and cleaning procedures after the lab.
- Clean up any spills immediately

Activity 10
Investigate Like a Scientist

30 min

Hands-On Investigation: Up the Stem

Instructional Purpose

In this activity, students observe the function of the plant stem and interpret the data to further refine their models of plant structures.

Scientific Context

This Hands-On Investigation builds upon the work that students have started regarding presentation of their findings and extends students' data collection and observation skills.

Life Skills **Creativity**

Activity Activator: Make a Prediction

In this Hands-On Investigation, students will use the information gained in prior activities as they observe how water and nutrients move from the roots of a plant up through the stem to its leaves and flowers through tubes called xylem.

Arrange students in groups of three or four. Before beginning the investigation, direct students to explain their current understanding of the xylem and its function. If needed, show a clip of the video Parts of a Plant, from 2:25 to 2:32.

Students may recall doing a similar experiment in a prior year. However, in this investigation, students will take a closer look at the vascular bundles.

Sample student responses shown.

Think about what you have learned from your research so far. Develop a claim about what you think will happen to the celery stalks when placed in the cup of colored water. Answers may vary. The xylem will turn into the color of the water in the cup.

Activity Procedure: What Will You Do?

1. In the first stage of the experiment, ask group members to examine the celery stalks closely. Students should record observations in the "Before" section of the data table about how the celery stalk looks.

2. Explain that students will be investigating transport in plants. Then, direct each group to put food coloring in the cup of water, snip about two centimeters off the bottom of the stalk or stem, and place it in the water.
3. Direct students to predict what will happen to celery stalks when placed in a cup of colored water. Encourage students to be specific in the prediction by drawing the celery stalk, including adding any color. Will the stalk turn color? If so, how far up? Will the leaves turn color? If so, how dark?
4. Leave the stalks in the water cups and set aside where they will not be disturbed for 24 hours. Students should be encouraged to make and record observations through the process.
5. If possible, students should check on their experiments periodically throughout the remainder of the day. Students should record early observations and compare the outcome with their predictions.
6. The following day, with an adult's assistance, use scissors or a knife to cut across the celery stalk, about 5 to 7 cm up from the bottom. Direct students to discuss and record observations. Ask students to identify the vascular bundles or xylem.
7. Next, cut the top part of the stalk lengthwise. Ask students to identify the xylem. Gently bend one of the long pieces backward until it snaps, leaving the xylem still visible. Direct students to record observations in words and diagrams.
8. Once students conclude the investigation and have recorded their findings, provide time for students to add more information to their summary frames from the previous two activities.

NOTE: If you are using flowers as well as celery, carry out the experiment in the same way with the flowers. You will find that the xylem tubes will not be as evident in the flower stems. However, the change in the color of the petals will be more prominent.

Student Page 26

Analysis and Conclusions: Think About the Activity

Direct students to record their final conclusions.

Sample student responses shown.

How did your predictions about the outcome of the investigation differ from your observations? Answers may vary. Students should compare their predictions to the outcome.

Video Lesson 5

Quick Code: egst5019

Lesson 5

DIGITAL

Quick Code: egst5018

Student Pages 27–31

Activity 11
Analyze Like a Scientist

20 min

Comparing Plant and Human Systems

Instructional Purpose

In this activity, students read a passage and discuss how plants and animals both rely upon complex systems of transport to move water, gases, and nutrients between organs within the organism.

Scientific Context

The transport system in both plants and the human body serves the same basic purpose. In both organisms, networks of vessels transport materials that sustain life. In plants, this system is designed to transport water, nutrients, and sugars. In the human body, blood transports nutrients and oxygen from the heart to organs throughout the body.

Life Skills **Creativity**

Strategy

Read the text aloud, asking students to raise a hand when new vocabulary words are heard. Display vocabulary words on the board for students to reference. Use context clues and previous lessons to clarify the meaning of each word. Discuss the comparisons made in the article between human and plant systems.

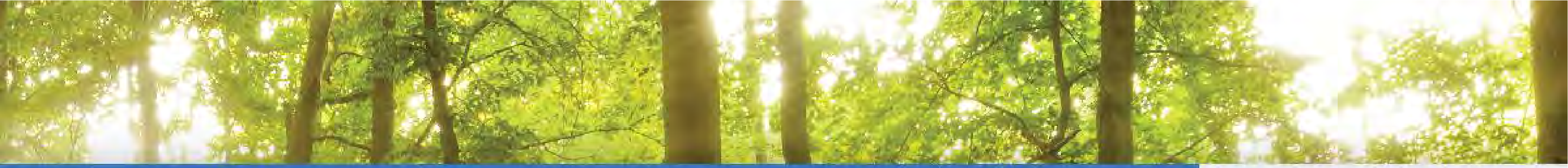
Next, ask students to partner with another student to reread the selection. Students should work together to further explain the selection.

Finally, direct partnered students to complete the Venn diagram to compare and contrast the systems.

ASK

- *How is the human system similar to plant systems?*
  Both need energy and gases from the air. Both have systems of vessels to transport nutrients and gases.
- *How is the human system different from plant systems?*
  Plants take in carbon dioxide and humans take in oxygen. The human system is the circulatory system that moves blood around our bodies. The plant system is called the transport system and moves important substances between parts of the plant.

Once students have read the article and completed the Venn diagram, either in pairs or as a class, ask students to share their thoughts about how to maintain heart health.



Sample student responses shown.

Plant Transport System

Water taken in through roots

Xylem tubes carry water to leaves

Phloem tubes carry sugars from leaves

Human Circulatory System

Arteries carry nutrients and oxygen-rich blood

Veins carry depleted blood back to the heart

Vessels move to and from heart and lungs

Similarities

Transport system transports life-sustaining substances

One-way tubes

Helps move gases and nutrients

Digital Extension Activity 12

Evaluate Like a Scientist

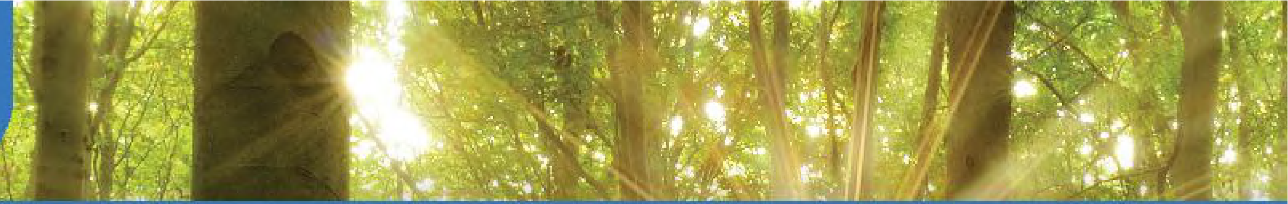
10 min

Obtaining Materials

Use this online extension activity to extend student exploration.

Quick Code: egst5020

Student Page 31



DIGITAL

Quick Code:
egst5021

Student Pages 32–33

Activity 13

Analyze Like a Scientist

15 min

Plant Food

Instructional Purpose

In this activity, students continue their models of how plants obtain the materials they need to survive and grow by focusing on the process a plant goes through to use the materials to make food. Students are asked to work collaboratively with a partner and reflect on their own work.

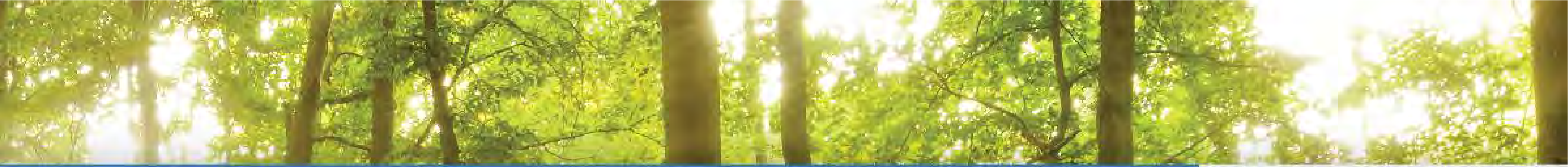
Scientific Context

Photosynthesis is the process by which plants use water, sunlight, and air to manufacture glucose. Students must also understand that energy can change from one form to another. In the case of photosynthesis, light energy is converted into chemical energy.

Life Skills **Endurance**

Strategy

- Direct students to read the text about how plants make food. Instruct students to number each step in the process as they read.
- Pair students with a partner and ask them to compare their numbering and come to consensus. As students compare, challenge them to identify the relationships between the structure of the plant and its function at each step.
- Post the steps and discuss with the class. Direct students to add the information to their charts during the class discussion.
- Ask students to summarize how materials move through the plant. If students have difficulty explaining their model, encourage students to think about how their model could be modified to show the movement of materials through a plant.



Sample student responses shown.

Read the text describing the process that converts energy from the sun into food. Number each step of the process in the paragraphs that follow. Then, compare and discuss your numbering with a partner. Once you and your partner agree, write the steps in the table that follows.

Step Number	Step Description
1	*Light from the sun hits a plant's leaves.*
2	*The leaves transform light energy from the sun into glucose (chemical energy).*
3	*Vessels move glucose from the leaves to other parts of the plant.*
4	*Plant parts use the glucose for their needs, such as growth.*
5	*Plants release oxygen that other living things need.*

Digital Extension Activity 14

Observe Like a Scientist

25 min

Leaves and Food Production

Use this online extension activity to extend student exploration.

Quick Code:
egst5022

Student Page 33

DIGITAL

Quick Code:
egst5024

Student Page 34

Activity 15
Observe Like a Scientist

10 min

Flowers and Seeds

Instructional Purpose

In this activity, students look for specific evidence in a video to help them explain how plants use the food they make to produce flowers.

Scientific Context

Many plants rely on flowers to reproduce. The function of a flower is to manufacture seeds for the plant.

Life Skills **Critical Thinking**

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

- Before viewing the video, review with students the needs of plants. Ask students to infer what plants do with the food they make.
- Show students the video What Is a Flower? and ask them to look for evidence to explain how plants use the food they make. Students should compare and contrast the evidence provided in the companion text with the video evidence.
- After viewing the video, arrange students in groups of three. Ask each group to discuss their ideas of what plants do with the food they make. Students should also discuss why flowers and seeds are important to the plant.

MISCONCEPTION

Students may think that all plants make flowers and seeds. Many plants do have flowers; however, some plants do not use flowers to reproduce. Some examples of these plants are conifers, which reproduce using cones, and ferns, which reproduce using spores. Plant reproduction by cones or spores is a higher level concept and should not be introduced at this time. Focus the discussion in this activity on reproduction via flowers.

Video Lesson 6

Quick Code: egst5023

Activity 16
Investigate Like a Scientist

30 min

Hands-On Investigation: Seed Dispersal

Instructional Purpose

In this activity, students design and test models of imaginary seed designs to investigate methods of seed dispersal.

Scientific Context

One way many plants use the food they make is by producing seeds. Seeds must travel away from their parent plant so that a young plant will not have to compete with an established plant for resources. Some of the ways that seeds travel are wind, water, sticking to animal fur, or travelling in an animal's digestive system to a new location.

Life Skills **Creativity**

Activity Activator: Make a Prediction

To introduce the activity, ask students to describe the properties of the seed in the picture Burr Seed. Ask students to share what they know about other seeds as well.

Lead a discussion with students on how seeds move.

ASK

- *How do seeds move?*
  Answers will vary. Students may mention seeds falling, being carried by a human or animal, or being moved by water or wind.
- *How far do they go?*
  Answers will vary.
- *What might carry them?*
  Answers will vary. Students may mention animals eating and then excreting seeds, seeds getting stuck to animal fur or to articles of human clothing. Students may also mention seeds being carried by moving water or blowing in the wind.

After students share ideas, explain that they are going to look at seed samples or images of seeds and predict how they move. Ask students to observe the seeds in the pictures in their textbooks and make a prediction about how each of them would be transported.

DIGITAL

Quick Code: egst5025

Student Pages 35–38

Materials List
(per group)

- Paper
- Pencils
- Pan of water
- Sample seeds or images of seeds (suggested types include coconut, maple, dandelion, burdock, apple, and tomato)
- Fan or access to an outside area
- Piece of carpet or fuzzy blanket (to represent animal fur)
- A variety of model-building materials. Items may include (but are not limited to): modeling clay, tissue paper, toothpicks, sequins, chenille stems, masking tape, cotton balls

Lesson 6, *continued*

Safety

- Follow all lab safety guidelines.
- Follow proper disposal and cleaning procedures after the lab.
- Clean up any spills immediately

Guide students to review each image or seed sample and start to classify them based on their predicted movement. Suggested seeds are coconut, maple, dandelion, burdock, apple, and tomato. If possible, share seed samples that are native to your area with students in addition to the photographs. Use the questions that follow to help students examine each seed.

ASK

- *If we put this seed in a cup of water, does it float?*
  coconut
- *If we blow on it, does it float or travel in the air?*
  maple, dandelion
- *Could this stick to your socks or clothes? Would it stick to animal fur?*
  burdock
- *Does this look good enough to eat? How would animals move the seed by eating them?*
  apple, tomato

Next, ask students to summarize the way the seeds move in nature based on their observations. Students should identify and describe how seeds can move by floating on water in rivers or lakes, traveling by wind, sticking to animal fur, and being eaten and then deposited by animals. Chart the four dispersal methods on the board: water, wind, animal movement, and being eaten.

Explain to students that they will design models for different ways seeds can be dispersed.

Student Page 36

Sample student responses shown.

Which method of dispersal do you think is highly effective at moving seeds from one place to another? Answers may vary.

How will you make dispersal for your model seed possible? Draw what your model seed will look like in the space provided. Answers may vary. Sketches should indicate a plan for construction of a seed model.

Activity Procedure: What Will You Do?

Part 1: Traveling Seeds

1. Provide groups of three or four students with sample seeds or photographs of seeds that disperse in different ways.
2. Using the photos as a guide, give the students time to decide, as a team, which dispersal strategy they would like to investigate—water, wind, or animal transport.
3. Students then preview the items available for prototype construction.
4. Each student then sketches a model of an imaginary seed that would be perfectly designed to match the dispersal strategy chosen by the team.
5. Once sketches are complete, team members present and discuss their drawings and choose one design to build.
6. As a group, students select materials. Then, students build and test a prototype seed to investigate how well their model seed is able to travel.
7. Students use either the pan of water, an area with moving air, or the piece of carpet or fuzzy blanket to test their seed.
8. Once students have tested their models, they then record their results.

Part 2: Organize Data

1. In their groups, students evaluate their model and discuss the efficacy of the prototype design.
2. Students share their models and results with the class.
3. As a class, students discuss which methods were most effective and whether or not this is reflective of the most highly effective strategies in nature.

Sample student responses shown.

Notes: Which method is your model seed designed for?
Student response should include one of the following methods: water, wind, animal transport.

Observations: What happened?
Answers may vary but should describe the testing process as well as the outcomes.

Student Page 38

Analysis and Conclusions: Think About the Activity

At the end of the investigation, ask students to respond to the Analysis and Conclusions questions.

Sample student responses shown.

What parts of your model seed aid in dispersal? Answers may vary. We used sequins to represent structures that might catch on animal fur and be transported along with the animal.

What kinds of seeds do you think are the most easily transported? Why? Answers may vary. I think that light seeds with some kind of spikes on the outside are better than heavier seeds that are round or smooth.

Did your model function as you predicted it would? Explain. Answers may vary. Yes, I thought that the spikes would hold onto the piece of carpet. I did not think it would be so hard to get off though.

How could you improve your model or test? Answers may vary. We could repeat the test for more trials, or we could use more materials.

DIGITAL

Quick Code: egst5027

Student Pages 39–41

Activity 17
Record Evidence Like a Scientist

15 min

Tree Needs

Instructional Purpose

In this activity, students return to the questions posed at the beginning of the concept and reconsider what they know now. Students construct a scientific explanation about the Investigative Phenomenon Planting a Tree and the Can You Explain? question.

Scientific Context

The process of writing a scientific explanation using evidence to support a claim is a key step in students constructing scientific knowledge that they can then use and apply.

Life Skills **Creativity**

Strategy

Display the Investigative Phenomenon of Planting a Tree and the Can You Explain? question. Ask students to discuss and share with the class or a partner their explanation for the Investigative Phenomenon.

Sample student responses shown.

How can you describe Planting a Tree now? Answers may vary. Students should reference detailed parts of plants, the function of leaves and flowers and so on.

How is your explanation different from before? Answers may vary.

After allowing students to discuss,

ASK *How can this explanation help you answer the Can You Explain? question?*

Can You Explain?

How do the structures of a plant use water, air, and light to perform life processes?

Lesson 6, *continued*

Students should be familiar with the process of using evidence to support a claim. You may want to review the following:

A **claim** is a one-sentence answer to the question you investigated. It answers, What can you conclude? It should not start with *yes* or *no*.

Student Page 40

Sample student responses shown.

My claim: *Answers may vary. Plants use specialized structures to obtain their basic needs of water, air, and light. Each part of a plant has a function to help it survive.*

Evidence must be:

- Sufficient—Use enough evidence to support the claim.
- Appropriate—Use data that support your claim. Leave out information that does not support the claim.

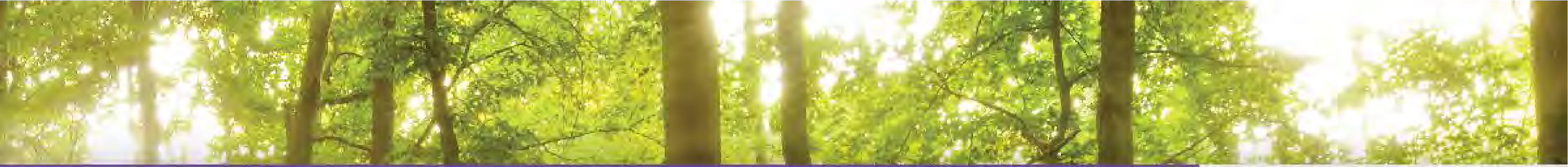
At this level, students should be able to construct a scientific explanation that includes reasoning as part of the explanation.

Reasoning ties together the claim and the evidence, and:

- Shows how or why the data count as evidence to support the claim.
- Provides the justification for why this evidence is important to this claim.
- Includes one or more scientific principles that are important to the claim and evidence.

Sample student responses shown.

Evidence: *Answers may vary. In most plants, the roots soak up water and nutrients from the soil and then the stem moves the water up to the leaves. We saw this take place in our investigation Up the Stem. The leaves of the plant take in air and absorb sunlight and use them to create glucose, its food. We know from our investigation, Sunlight: A Basic Need, that plants do not thrive in the absence of sunlight.*



After providing scaffolding to students, allow them time to construct a full scientific explanation. Students can write, draw, or orally describe their claim, evidence, and scientific explanation that includes reasoning.

If time allows, invite students to share their claim, evidence, and scientific explanation with reasoning. Student answers in all sections will vary. Sample student answers are provided as a benchmark for possible responses.

Sample student responses shown.

Scientific explanation with reasoning: *Answers may vary. Plants use specialized structures to obtain their basic needs of water, air, and light. Each part of a plant has a function to help it survive. In most plants, the roots soak up water and nutrients from the soil and then the stem moves the water up to the leaves. The leaves of the plant take in air and absorb sunlight and use them to create glucose, its food. Vessels in the plant transport the food throughout the plant. Sunlight is transformed into chemical energy in the leaves. If a plant does not have its basic needs met, it will not grow and may die.*

Student Page 41

Digital Extension Activity 18
Analyze Like A Scientist

10 min

Farmers Growing Plants: Irrigation

Use this online extension activity to extend student exploration.

Quick Code: egst5029

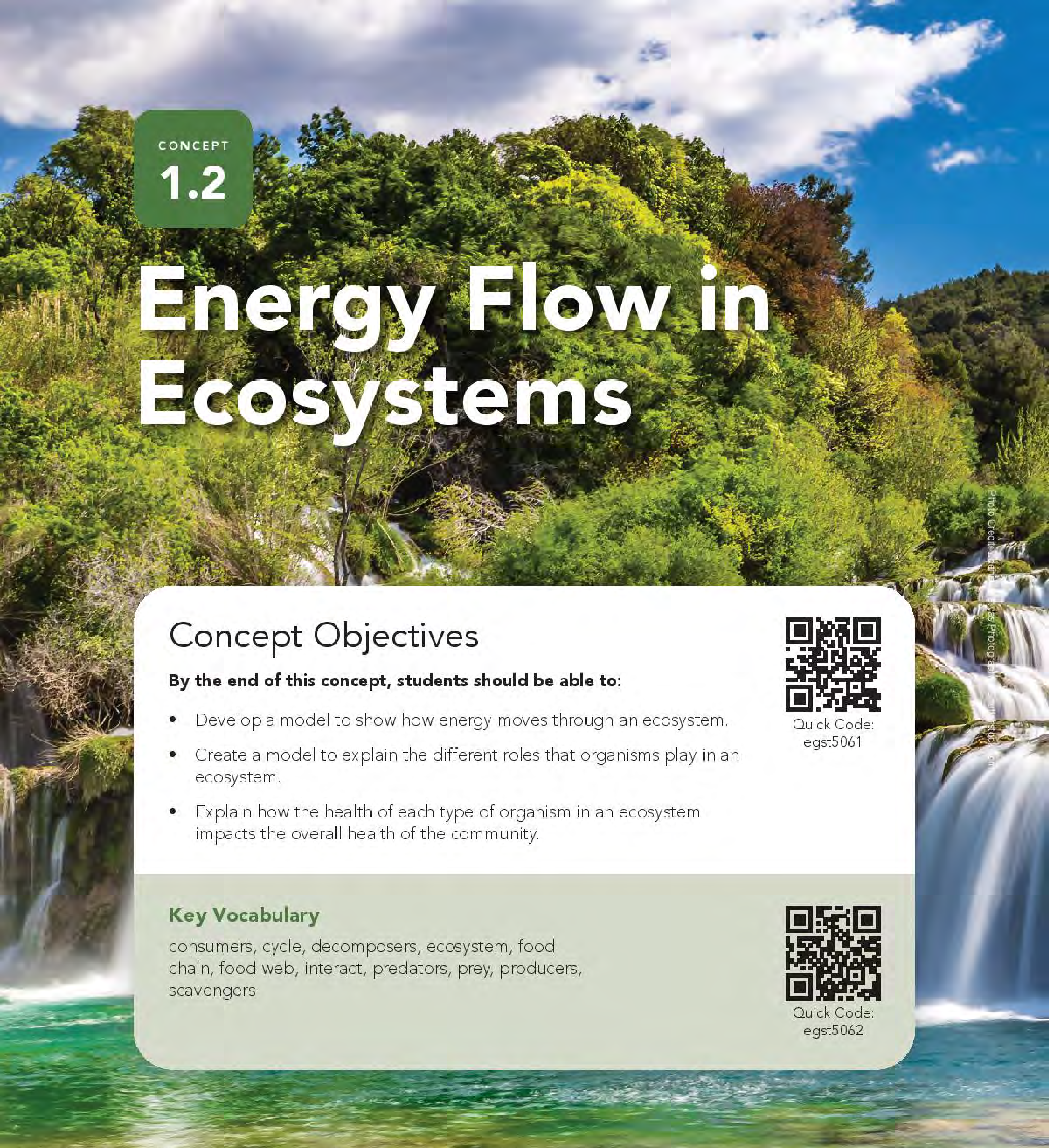
Digital Extension Activity 19
Evaluate Like a Scientist

15 min

Review: Plant Needs

Use this online extension activity to extend student exploration.

Quick Code: egst5030



CONCEPT

1.2

Energy Flow in Ecosystems

Concept Objectives

By the end of this concept, students should be able to:

- Develop a model to show how energy moves through an ecosystem.
- Create a model to explain the different roles that organisms play in an ecosystem.
- Explain how the health of each type of organism in an ecosystem impacts the overall health of the community.

Quick Code:
egst5061

Key Vocabulary

consumers, cycle, decomposers, ecosystem, food chain, food web, interact, predators, prey, producers, scavengers

Quick Code:
egst5062

Concept Pacing

Recommended Pathway

In order to meet the expectations of the standards, students must complete each activity within the recommended pathway.

Location	Days	Model Lesson	Time
Wonder	Lesson 1	Activity 1	5 min
		Activity 2	10 min
		Activity 5	15 min
Learn		Activity 6	15 min
	Lesson 2	Activity 7	25 min
		Activity 8	20 min
	Lesson 3	Activity 9	20 min
		Activity 10	25 min
	Lesson 4	**Activity 11**	45 min
	Lesson 5	Activity 12	20 min
		Activity 14	25 min
Share	Lesson 6	Activity 16	25 min
		Activity 17	20 min

Quick Code:
egst5063

Bold activities are Hands-On Investigations.
A full list of materials required, along with any additional preparation, can be found online.

Content Background

Children are fascinated by nature from a young age. Watching how animals interact with their surroundings is how many children first begin to develop a love of science. Students may not automatically think about how interconnected living things are with our environment. Every type of living thing is a critical link in a delicate chain. If one part of a living community is threatened, then the entire ecosystem is affected. Science education must help students understand the complex intersections that form ecosystems. Educators today must stress to students the connection that people have to the life sustaining services that nature provides. With this understanding, the students of today will become advocates for the health of our planet in the future.

Food Chains and Food Webs

All organisms on Earth are connected to one another by a flow of energy. The sun is the primary source of energy for all organisms. Radiant energy from the sun is converted to chemical energy in plants and the basis of food chains is formed. Plants are called producers because they are able to produce their own food. Consumers are organisms that must eat for energy. The transfer of energy from producer to consumer, such as when an animal eats a plant, is the first transfer of energy between organisms in a food chain. Food chains can be very short. Apple to human, for example. They can also be much longer. Grass to caterpillar, caterpillar to bird, bird to snake, for example. Consumers in longer chains are classified by those who eat producers—called primary consumers—or those who eat other animals further up the food chain—called secondary and tertiary consumers.

A system of several food chains makes up a food web that represents many feeding relationships in an ecosystem. Most organisms depend on more than just one other species for food. For this reason, food webs can often be quite complex, with many intersections and overlap between organisms.

Decomposers

Decomposition is an important natural process that breaks down organic material into smaller parts and simpler substances, such as minerals, water, and gases. All living things eventually die and decompose. The process can take months or even years to complete. Decomposers, such as fungi, mold, microorganisms, and bacteria, help break down dead organisms and waste into nutrients. These nutrients are recycled into the soil to aid the growth of new plants. Animals feed off these plants, and the cycle continues.

Video Lesson 1

Quick Code: egst5064

Activity 1
Can You Explain?

5 min

How does energy flow through an ecosystem?

Instructional Purpose

In this introductory activity, students communicate prior knowledge about how energy flows in ecosystems.

Scientific Context

In almost all ecosystems, energy begins with the sun. Producers use energy from the sun to produce their own food. Consumers get energy by eating other organisms. As plants and animals die, decomposers recycle the energy back into the environment.

Life Skills **Endurance**

Strategy

Display the Can You Explain? question so that all students can see it. Ask students to explain what is meant by energy flow. Limit discussion at this point to clarifying the question. Encourage students to explain what they know about the different types of organisms that make up an ecosystem. Challenge students to think about what they already know about how plants and animals obtain energy.

Students may have some initial ideas about how to answer the question. Students should be able to construct a scientific explanation by the end of the concept. The explanation will include evidence from the concept activities. Keep in mind that students' answers may not be fully formed at this point in the concept.

Sample student responses shown.

How does energy flow through an ecosystem? Answers may vary. Energy moves through an ecosystem from plants to animals and between animals where they eat each other. All living things die and then their energy is returned to the soil.

DIGITAL

Quick Code: egst5065

Student Page 43

DIGITAL

Quick Code:
egst5066

Student Pages 44–46

Investigative Phenomenon

Activity 2
Ask Questions Like a Scientist

10 min

How Hawks Get Energy

Instructional Purpose

In this activity, students apply prior knowledge of interactions among and between animals and the environment to develop a model and formulate questions that can be investigated.

Scientific Context

The basis for many biological processes in ecosystems, such as the food chain, is the interaction between animals and the environment.

Strategy

Show students the image Let's Investigate How Hawks Get Energy. Use this photo to generate a discussion about what kinds of food hawks eat.

ASK

- *What does a hawk eat?*
  Hawks generally eat snakes, mice, fish, birds, squirrels, rabbits, and other small ground animals.
- *What does the hawk get from the food?*
  The hawk gets energy.
- *Does the hawk rely on energy from plants in any way?*
  Hawks do not eat plants, but they eat animals who eat plants, so they also rely on plants for energy.
- *Does anything eat the hawk?*
  Hawks are at the top of their food chain and have few predators. However, hawks can be attacked by eagles or other hawks.
- *What happens when the hawk dies?*
  When a hawk dies, it decomposes. The food chain continues because decomposers have obtained energy by consuming the hawk.

After a brief discussion, guide students to consider their own questions about the hawk and how it gets energy.

Sample student responses shown.

I wonder . . .	*Answers may vary. Do hawks eat grass?*
I wonder . . .	*Answers may vary. What does a hawk eat?*
I wonder . . .	*Answers may vary. Does anything eat the hawk?*

Draw a model of how a hawk interacts with the environment. You can use words, images, and symbols. Models will vary.

Digital Extension Activity 3

Analyze Like a Scientist

15 min

All Animals Need Food to Survive

Use this online extension activity to extend student exploration.

Quick Code: egst5067

Digital Extension Activity 4

Observe Like a Scientist

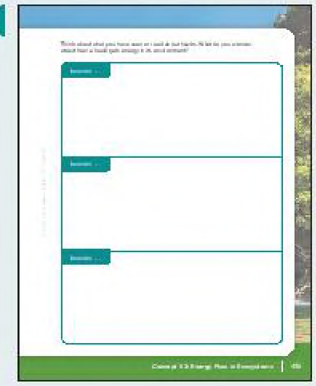
5 min

Decay

Use this online extension activity to extend student exploration.

Quick Code: egst5069

Student Pages 45–46

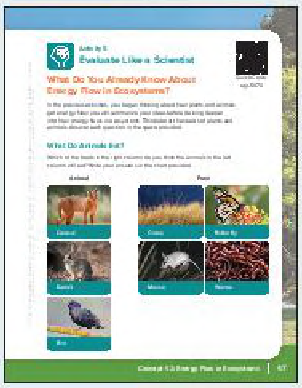


Lesson 1, *continued*

DIGITAL

Quick Code:
egst5070

Student Pages 47–49



Student Page 48

Activate Prior Knowledge

Activity 5

Evaluate Like a Scientist

15 min

What Do You Already Know About Energy Flow in Ecosystems?

Instructional Purpose

In this formative activity, students communicate prior knowledge of what different animals eat. Students also define and provide examples of ecosystems.

Scientific Context

An ecosystem is a community that contains both biotic (living) organisms and abiotic (non-living) factors. A healthy ecosystem sustains life by providing food, water, and shelter to all living members.

What Do Animals Eat?

Strategy

This item provides a formative assessment of students' existing knowledge about the different types of foods that animals eat. The assessment may lead to a discussion about grouping animals into categories according to the types of foods they eat.

Sample student responses shown.

Which of the foods in the right column do you think the animals in the left column will eat? Write your answers in the chart below.

Animals	Food
Caracal	*Mouse*
Rabbit	*Grass*
Bird	*Butterfly, Worms*

Why Eat Plants or Animals?

Strategy

This item provides a formative assessment of student understanding that food contains energy that is passed through a food chain. Students may have the misconception that animals choose what to eat based on taste preferences. Help students understand that what is eaten is based on what is needed by that particular animal's body for survival.

Sample student responses shown.

Think about what you already know. Why do animals eat plants or other animals? Answers may vary. Animals need energy that comes from eating plants and other animals because they cannot produce their own food.

Ecosystems

Strategy

This activity provides a formative assessment of students' prior knowledge about what an ecosystem is. It also provides an opportunity to address the possible misconception that ecosystems are simply food chains with just one animal eating another single animal or plant.

Sample student responses shown.

What is an ecosystem? An ecosystem is a community of living things, non-living things, and the environment.

What are some examples of ecosystems? Answer may vary. Responses should indicate an understanding that typical ecosystems would contain many kinds of lifeforms. Examples include an ocean, a rain forest, a desert, or the tundra.

What is the relationship between sunlight and the energy we get from our food? The energy we get from food originally came from the sun.

Student Page 49

Teacher Reflection

- What content do my students already know?
- What misconceptions do my students have at this point in the course?
- Are any of my students ready for extension at this point in the lesson?

Lesson 1, *continued*

DIGITAL

Quick Code:
egst5071

Student Pages 50–51


Analyze Like a Scientist
Food Is Energy

Activity 6
Analyze Like a Scientist

15 min

Food Is Energy

Instructional Purpose

In this activity, students read text and gather evidence to support or refute initial ideas about how energy flows through an ecosystem.

Scientific Context

The source of energy for all organisms on Earth is the sun. Some animals eat plants, while others rely on other living things for food. No matter how animals get their food, the original source of energy comes from the sun. Radiant energy is converted to chemical energy in plants and then is passed to animals. Scientists use a food chain to model the passing of energy from the sun to plants, plants to animals, and animals to other animals.

Strategy

Activate students' prior knowledge by asking them to think about what they ate for breakfast.

ASK *How does the food we eat give us energy? What happens to us when we do not eat good, healthy food or when we do not eat enough?*
Answers may vary. Food gives us energy to move and to exercise. If we eat junk food, we may feel sick or tired. When we do not eat enough, we may feel weak.

After a brief discussion, refer students back to answer to the Can You Explain? question and any questions generated during Wonder. Call on student volunteers to share their initial questions. Assign students to read the text with a partner. Direct students to look for evidence in the text that supports or refutes their ideas.

Video Lesson 2

Quick Code:
egst5068

Activity 7
Observe Like a Scientist

25 min

Food Chains

Instructional Purpose

In this activity, students gather evidence to further refine models of energy flow in ecosystems.

Scientific Context

The movement of energy and nutrients through an ecosystem can be modeled using a food chain. Plants use the energy from the sun to help produce food. Animals eat plants, moving energy up the food chain. Energy is transferred further along the chain as plant eating consumers are eaten by other consumers. The final link in the food chain is the decomposers.

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

Direct students to watch the video. Ask students to record any questions or important facts to share later with one another in the margins of the Student Materials.

Divide students into groups of three to read the text. Once finished, each student should reflect on what they know about organisms in food chains, using the prompt in the Talk Together box. At this point in the unit, students should be developing more sophisticated ideas about the relationships between organisms in an ecosystem.

Allow time for small-group discussion.

DIGITAL

Quick Code:
egst5073

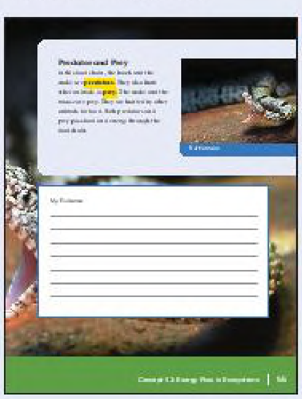
Student Pages 52–53

DIGITAL

Quick Code:
egst5074

Student Pages 54–55

Student Page 55



Activity 8
Analyze Like a Scientist

20 min

Energy Flow

Instructional Purpose

Students gather evidence from text about food chains and learn about the roles organisms play in the transfer of energy.

Scientific Context

The transfer of energy from producer to consumer, as one organism feeds on another, forms the beginning links between organisms in a food chain. As consumers eat consumers, the relationships become more complicated. Any animal that is eaten by another is called prey. The consumer who eats that animal is called a predator.

Strategy

Assign students to read the text and underline evidence about what would happen if an organism was removed from the ecosystem. Next, have student pairs compare what they underlined.

Lead a class discussion to review the importance of energy in an ecosystem. Reiterate that energy can be transferred in various ways between organisms.

The concepts surrounding energy may be difficult for students to grasp because energy is not tangible. To help students solidify their understanding of energy flow in an ecosystem, ask student pairs to generate lists of other food chains. Students should identify organisms as producers or consumers, predator or prey.

Direct student pairs to share the generated lists with another pair of students. Encourage groups to explain the process in each chain.

Continue the whole group discussion by asking what would happen to the flow of energy if the chain was disrupted.

Sample student responses shown.

My Evidence: *Answers may vary.*

Video Lesson 3

Quick Code: egst5072

Activity 9
Evaluate Like a Scientist

20 min

Food Chain

Instructional Purpose
In this formative assessment activity, students demonstrate understanding of the predator-prey relationships among organisms by constructing a model of a food chain to show the feeding relationships between the organisms.

Scientific Context
The predator-prey relationship is an interaction between two species. These relationships make up a significant portion of most ecosystem food webs. One predator may depend on many different types of organisms as prey. Predators serve a vital role in keeping populations of prey in balance.

Life Skills **Decision-Making**

Strategy
Use this item as a formative assessment of students' understanding of predator-prey relationships. Not all students may know what foods specific organisms eat. Provide this information to students or allow time to research the topic. Then, ask students to construct a model based on this information to illustrate the feeding relationships between the organisms.

Extend the activity by discussing whether all feeding relationships are linear.

ASK

- *How would you add a grass-eating mouse that the snake eats to your model?*
  Answers may vary. The mouse would form the link between the grass and the snake.
- *What other animal might be included in your model? Where would it be added?*
  Answers may vary.
- *What has changed in your model by including a new animal?*
  Answers may vary.

DIGITAL

Quick Code: egst5076

Student Page 56

Lesson 3, *continued*

Sample student responses shown.

Write the names of the organisms in the correct boxes to make a food chain.

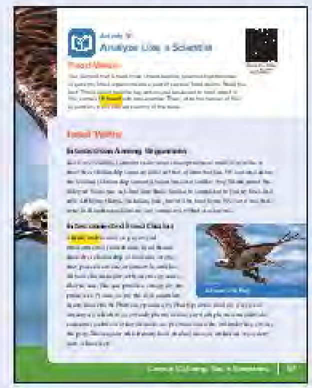
Grass → Grasshopper → Bird → Snake → Hawk

How would you add a grass-eating beetle that the bird eats to this model?
An arrow from the grass would point to a beetle. Then, add an arrow from the beetle to the bird.

DIGITAL

Quick Code: egst5077

Student Pages 57–58



Activity 10

Analyze Like a Scientist

25 min

Food Webs

Instructional Purpose

Previously, students constructed a model of a food chain to show feeding relationships among organisms. Students build on that understanding by creating a model of a food web showing how several food chains interact.

Scientific Context

Food chains show the relationship of food and energy that passes from one organism to the other. Food webs show how many food chains are interconnected. All living things interact in food webs.

Strategy

As a class, generate a list of living organisms with which students are familiar. Tell students they will create a model that shows how energy flows through living things.

Direct students to read the reading passage Food Webs. Then, ask students to connect the vocabulary terms from the passage, such as *producer, predator,* and *prey,* to the organisms they listed.

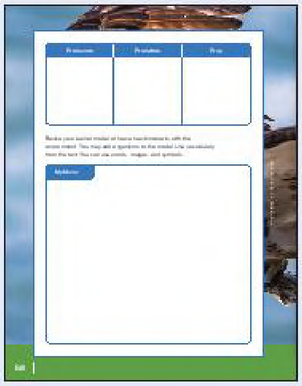
ASK *How can you modify your list to create a food web? What would you need to add to make it a model?*
Answers may vary. A food web is made of food chains, so I would need to list animals from different food chains to make my food web. I would need to add the sun and a producer to make it a model. I would also need to add relationships between predators and prey.

As a class, use the organisms in the list to create a food web. You might need to add organisms to the list or exclude others from the model.

ASK

- *Who is eating whom?*
  Answers may vary.
- *What do the arrows show?*
  The arrows show the transfer of energy between organisms.

Student Page 58



Sample student responses shown.

Think about how the organisms you observed or read about in this concept interact with each other. Then, write the names of the organisms in the correct column of the table.

Producers: *grasses, trees*

Predators: *hawks, snakes*

Prey: *mice, insects*

Revise your earlier model of how a hawk interacts with the environment. You may add organisms to the model. Use vocabulary from the text. You can use words, images, and symbols.

My Model: *Drawings should now include predator and prey relationships in addition to depicting the producer for the ecosystem.*

Video Lesson 4

Quick Code: egst5075

Activity 11
Investigate Like a Scientist

45 min

Hands-On Investigation: Food Webs in the Neighborhood

Instructional Purpose

In this activity, students explore outdoor habitats to make observations to develop a food web model that describes energy flow and feeding interactions in an ecosystem.

Scientific Context

Food webs can be used to show how organisms that live in an area depend on each other for survival. If an organism in the local environment is removed, the larger ecosystem would be disrupted because some organisms lose a food source and other organisms lose a predator. Depending on the organism removed, the ecosystem may even collapse.

Activity Activator: Make a Prediction

Before students begin, review safe practices for investigating outdoors, including avoiding harmful organisms and washing their hands when they return.

Arrange students in groups to generate ideas about organisms that they will need to look for to produce a food web of the local ecosystem. Ask students to consider the types of plants or animals they expect to find outside. To support students' planning of this descriptive investigation, guide them in formulating questions. Record these questions and refer to them as students go through the activity.

Sample student responses shown.

Make a prediction about what types of plants or animals you will find outside. Do you think you will be able to observe predator-prey relationships? What other questions do you have as you consider the food webs in our school neighborhood? *Answers may vary. Students should mention local plants and animals. Students may have questions about the role of humans in the local ecosystem.*

Activity Procedure: What Will You Do?

1. On a day that permits extended outdoor time, take students outside for a short walk through the neighborhood. A local park or the schoolyard may provide enough habitat for students to identify organisms in the ecosystem.

DIGITAL

Quick Code: egst5079

Student Pages 59–62

Materials List
(per group)

- Hand lens
- Colored pencils
- Camera (optional)

Safety

- Follow all lab safety guidelines.
- Be careful when approaching any organisms in their natural environments.
- Be aware that some plants and animals can be harmful. Do not touch these.
- Do not taste, eat, or drink anything that you find during your field exploration.
- Wash your hands when you return from your field experience.

Lesson 4, *continued*

Give students time to explore the area and note the different types of organisms that live there. Students should pay particular attention to energy relationships in the environment and make observations of these relationships. Where are plants located in the environment, and how do they obtain energy? Are there animals on or near the plants? How do these animals obtain energy? How does each organism fit into the flow of energy through this ecosystem?

2. Students should use tools such as notebooks, hand lenses, and cameras to make and record their observations. Encourage students to move slowly, being careful not to disturb anything that might provide food, shelter, or water for an organism. Students should document their observations by taking notes, snapping photos, and making sketches in their science notebooks.
3. Upon returning to class, students should arrange the organisms they observed in a food web. They should print out pictures or copy sketches from their observations to form the nodes of the web. Students will not be able to observe all predator-prey interactions in the limited time they have for observation. Encourage students to fill in missing relationships on their food webs by researching the consumption habits of the organisms they have identified. If they did observe any feeding activities directly, they should document that on the food web as well.

Student Page 62

Sample student responses shown.

Food Web: *Answers may vary. Drawings should include multiple organisms from students' exploration of the environment*

Analysis and Conclusions: Think About the Activity

Sample student responses shown.

What organisms did you place in your food web, and how are they related to one another? Answers may vary. Student responses should describe how different organisms relate to each other in terms of food source.

What types of plants, both living and dead, did you observe? What can you infer about the needs of these organisms? Answers may vary. Students' responses should describe examples of both living plants and dead plant material on top of or in soil. Students should also explain that plants need soil, water, sunlight, and air.

Video Lesson 5

Quick Code: egst5078

Activity 12
Evaluate Like a Scientist

20 min

Interactions in Food Webs

Instructional Purpose

In this formative assessment activity, students develop a food web model and use evidence to justify how the model represents interactions among organisms and energy flow.

Scientific Context

Food webs show interactions among many food chains. Rather than providing an isolated look at one set of feeding relationships, they show many intersecting relationships within an ecosystem. Food webs show how various organisms within an ecosystem are connected to one another though other living things.

Strategy

In this item, students develop their own model of a food web and explain how food webs can be used to describe interactions of organisms. After students have created their models, organize them into small groups. Give each student time to explain to the rest of the group the feeding relationships found in their web and how energy is transferred.

DIFFERENTIATION

Approaching Learners

This item requires written explanations and then a detailed model. For students who do not seem to fully understand the ideas behind food webs, you may wish for them to dictate their responses. You might also pull struggling students aside and talk through the items individually or in small groups. The point of this formative assessment activity is to help students communicate what they know at this point in the unit. Give students multiple ways to communicate and allow for partially formed explanations and responses.

DIGITAL

Quick Code: egst5081

Student Pages 63–64


Activity 12
Evaluate Like a Scientist
Interactions in Food Webs

Lesson 5, *continued*

Student Page 64

Sample student responses shown.

How do food webs model interactions among organisms in an ecosystem? Food webs show that many different organisms share food resources within ecosystems. They show how these interactions connect organisms within an environment. Several different consumers may eat the same producers or prey.

How does a food web represent a system for the transfer of energy? Food webs show that various organisms within an ecosystem are connected as producers and consumers. Organisms eat and are eaten in order to obtain and pass on energy. All organisms within the food web need energy to survive. Producers get energy from the sun. They then become food for consumers. Consumers must eat for energy. Many consumers then become food for other consumers, which also must eat producers or other consumers for energy.

Why is a food web a better choice to use to show interactions among organisms than food chains? Food webs show interactions among many food chains. Rather than showing just interactions between just a few organisms, they show many overlapping relationships within an ecosystem.

Now, draw a diagram of your own food web for an ecosystem of your choosing. Be sure to include at least five different organisms in your food web. Answers may vary. Diagrams should show an accurate food web for the chosen ecosystem and include at least five different organisms.

Teacher Reflection

- Do students understand how energy is transferred in a food web?
- Are students able to explain feeding interactions in a food web?
- Are students able to explain that a food web is able to show information that a food chain is unable to show?

Digital Extension Activity 13

Observe Like a Scientist

25 min

Decomposition

Use this online extension activity to extend student exploration.

Quick Code:
egst5082

Activity 14
Analyze Like a Scientist

25 min

What Are Decomposers?

Instructional Purpose

In this activity, students gather additional evidence about the role of decomposers in the flow of energy in an ecosystem. Students create a visual display about the lifetime of an organism in the ecosystem, including the cycle from producers to decomposers.

Scientific Context

Decomposers play an important part in the environment. They help break down dead plants and animals into nutrients that can be returned to the ecosystem. Decomposers are nature's recycling factory.

Strategy

After students read the text, lead a class discussion about decomposers. Ask students to share what role decomposers play in energy transfer. Challenge students to predict what would happen if decomposers did not exist.

Direct students to read the text again and underline or highlight any characteristics of a decomposer.

The SOS Strategy: Fakebook Page asks students to create a social media profile page. If students are unfamiliar with common social media platforms, take the time to explain how users update their status or timeline with important events in life. For example, a person might post an update with text and photos about getting a new job or going to a celebration. Users also have friends online, and can comment on updates posted by their friends.

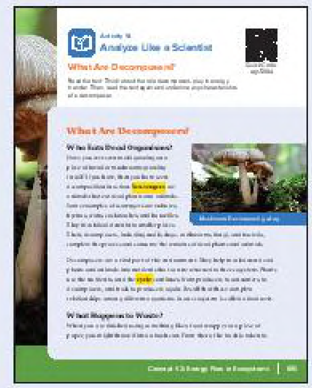
Direct students to create a page from the perspective of a log being decomposed. Ask them to update their timeline, starting with scavengers in their food web. This SOS strategy allows students to explore the life of a person (or thing) of interest and organize their thoughts and ideas in the form of an imaginary social media profile page. The Fakebook page can be made with construction paper and markers, or you can design a template for students that includes a place for a photo, status updates, friends, and even an events section.

Consider including time for a gallery walk at the end of the activity. Allow students to ask one another questions about their models.

DIGITAL

Quick Code:
egst5084

Student Pages 65–66



Lesson 5, *continued*

Student Page 66

Sample student responses shown.

Then, read the text again and underline any characteristics of a decomposer.

- *"They break food down into smaller pieces."*
- *"consume the remains of dead plants and animals"*
- *"They help break down dead plants and animals into nutrients that can be returned to the ecosystem."*
- *"nature's recycling factory"*
- *"releases these nutrients back into the environment"*

Digital Extension Activity 15
Observe Like a Scientist

15 min

Composting

Use this online extension activity to extend student exploration.

Quick Code:
egst5085

Video Lesson 6

Quick Code: egst5080

Activity 16

Record Evidence Like a Scientist

25 min

How Hawks Get Energy

Instructional Purpose

In this activity, students return to the questions posed at the beginning of the concept and reconsider what they know now. Students construct a scientific explanation about the Investigative Phenomenon How Hawks Get Energy and the Can You Explain? question.

Scientific Context

The process of writing a scientific explanation using evidence to support a claim is a key step in students constructing scientific knowledge that they can then use and apply.

Life Skills **Creativity**

Strategy

Display the Investigative Phenomenon How Hawks Get Energy and the Can You Explain? question. Ask students to discuss and share with the class or a partner their explanation for the Investigative Phenomenon How Hawks Get Energy.

Sample student responses shown.

How can you describe How Hawks Get Energy now? *Answers may vary. Students should reference the role of a hawk in a food web or food chain They should use terminology including predators, prey, producers and consumers.*

How is your explanation different from before? *Answers may vary.*

After allowing students to discuss,

ASK *How can this explanation help you answer the Can You Explain? question?*

Can You Explain?

How does energy flow through an ecosystem?

DIGITAL

Quick Code: egst5087

Student Pages 67–69

Lesson 6, *continued*

Students have already reviewed sample scientific explanations in earlier units, so they should be familiar with the process of using evidence to support a claim. You may want to review the following:

A **claim** is a one-sentence answer to the question you investigated. It answers, What can you conclude? It should not start with *yes* or *no*.

Student Page 68

Sample student responses shown.

My claim: *Answers may vary. Energy moves through an ecosystem by consumption.*

Evidence must be:

- Sufficient—Use enough evidence to support the claim.
- Appropriate—Use data that support your claim. Leave out information that doesn't support the claim.

At this level, students should be able to construct a scientific explanation that includes reasoning as part of the explanation.

Reasoning ties together the claim and the evidence, and:

- Shows how or why the data count as evidence to support the claim.
- Provides the justification for why this evidence is important to this claim.
- Includes one or more scientific principles that are important to the claim and evidence.

Sample student responses shown.

Evidence: *We learned about food chains and food webs, where all of the energy starts with the sun. Producers get what they need for energy from the sun, and then other organisms consume the producers as food. We learned about decomposition, and how even when plants and animals die, they are providing food and energy for decomposers. We analyzed interactions between predators and prey, and investigated producer and consumer relationships in our own neighborhood.*

After providing scaffolding to students, allow them time to construct a full scientific explanation. Students can write, draw, or orally describe their claim, evidence, and scientific explanation that includes reasoning.

If time allows, invite students to share their claim, evidence, and scientific explanation with reasoning. Student answers in all sections will vary. Sample student answers are provided as a benchmark for possible responses.

Sample student responses shown.

Scientific explanation with reasoning: *Energy moves through an ecosystem by consumption. Plants are producers in an ecosystem. They are called producers because they can make their own food. They use energy from the sun to make their own food. Then, a consumer will eat the plant, like a bunny eating grass. Next, another consumer, such as a fox, will eat the bunny, and now the fox has the energy from the bunny that it got from the grass that it got from the sun. The energy moves through the ecosystem because animals eat other organisms. Even when something dies, it feeds decomposers that then help the soil so more plants can grow. It is a big cycle.*

Student Page 69

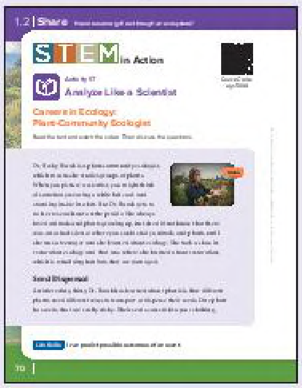
Teacher Reflection

- How has my students' construction of scientific explanations improved from earlier in the course?
- How did I provide scaffolding for students to construct their scientific explanations?
- How do I know my students are ready to apply the core content knowledge to another context?

DIGITAL

Quick Code:
egst5088

Student Pages 70–71



STEM in Action

Activity 17
Analyze Like a Scientist

20 min

Careers in Ecology: Plant-Community Ecologist

Instructional Purpose

In this activity, students obtain information about habitat restoration and seed dispersal while learning about a plant-community ecologist. Students then predict the outcome of an ecology experiment.

Scientific Context

Restoration ecology is vitally important to ensure that plants and animals have a stable environment in which to survive. Plant ecologists are scientists who work on restoration projects and conduct experiments that provide data to make better restorations.

Life Skills **Critical Thinking**

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

Begin by asking students to describe what scientists look like and where they do their work.

Direct students to watch the video Plant-Community Ecologist and read the text.

Ask students to share what interests them about the job of a plant ecologist. Also ask students to brainstorm the challenges of conducting experiments out in the field.

Instruct students to complete the Talk Together questions.

ENTREPRENEURSHIP

The career in focus in this activity is a plant-community ecologist. Encourage students to think about how the different parts of this career description exemplify entrepreneurship. This career focuses on plants, which can connect to the entrepreneurship skill of resource management. This career focuses on serving the community, which is a skill that many businesses work to perfect. Finally, the focus on ecology demonstrates the ability to set ambitious and achievable goals in the service of our environment.

Digital Extension Activity 18

Evaluate Like a Scientist

15 min

Review: Energy Flow in Ecosystems

This extension activity can be found online. Review activities allow students to summarize learning and apply information from the concept to the unit topic, or theme.

Quick Code: egst5089

CONCEPT

1.3

Changes in Food Webs

Concept Objectives

By the end of this concept, students should be able to:

- Demonstrate through modeling how changes in an ecosystem can disrupt a food web.
- Construct an explanation about how human activity can negatively impact an ecosystem.
- Argue for possible solutions to environmental problems that can restore the health of an ecosystem.

Quick Code:
egst5115

Key Vocabulary

climate, conservation, habitat, microorganisms, microplastics, nursery, pollution, population, restoration

Quick Code:
egst5116

Concept Pacing

Recommended Pathway

In order to meet the expectations of the standards, students must complete each activity within the recommended pathway.

Location	Days	Model Lesson	Time
Wonder	Lesson 1	Activity 1	10 min
		Activity 2	10 min
		Activity 3	10 min
		Activity 4	15 min
Learn	Lesson 2	**Activity 5**	30 min
		Activity 6	15 min
	Lesson 3	**Activity 7**	25 min
		Activity 8	20 min
	Lesson 4	Activity 9	20 min
		Activity 10	25 min
	Lesson 5	Activity 11	45 min
Share	Lesson 6	Activity 12	15 min
		Activity 13	20 min
		Activity 14	10 min
Unit Project	Lesson 7	Unit Project	90 min

Quick Code: egst5117

Bold activities are Hands-On Investigations. A full list of materials required, along with any additional preparation, can be found online.

Content Background

Transfer of Energy

As students begin the last concept in this unit, they have a working knowledge of the various roles that organisms play in an ecosystem. Students used models of food chains and food webs to study the complex nature of relationships that organisms have with their environment.

The transfer of energy from producer to consumer, as one organism feeds on another, forms a food chain. The sun is the initial source of energy for all organisms. A system of several food chains makes up a food web that represents many feeding relationships in an ecosystem. All organisms on Earth are connected to each other by a flow of energy. Energy from the sun is converted to chemical energy by green plants. Roughly 10 percent of this energy is then transferred to primary consumers, which are eaten by secondary consumers. Secondary consumers also receive roughly 10 percent of the total energy represented by the primary consumer. Because so little energy is transferred between organisms when one organism eats another organism, there is a larger number of organisms at the lower levels of a food web than at the higher levels of a food web. In addition, the small percentage of energy transferred between organisms requires a constant input of energy into all food webs. This constant energy input is accomplished by the ongoing process of photosynthesis by plants and the recycling of nutrients into the soil by decomposers.

Factors of Change in a Food Web

The interdependent relationship that organisms have with one another in an ecosystem means that a healthy ecosystem must be a balanced equation. In a stable ecosystem, living things have access to enough space and nonliving resources for survival. Animals in the community have sufficient food to grow and reproduce. Some changes within a food web are part of natural cycles, such as seasonal changes and breeding seasons. However, changes that are not part of the natural order can often have dramatic and detrimental effects on an ecosystem.

Human activity is increasingly to blame for imbalances in natural communities. Habitat loss, degradation, and fragmentation are some of the biggest problems that organisms face. Habitats that remain intact are often plagued with the problems of pollution. Discarded materials, such as plastic, release toxins into the environment and are often mistaken for food by animals. Marine litter, for example, is nearly 80 percent plastic. The loss of a suitable home is listed as the main threat to 85 percent of all threatened and endangered species.

With decreased habitat comes a loss of large predators, also known as apex predators. The decline of predators in an ecosystem has far-reaching ecological effects. Apex predators sit at the top of the food chain. When these predators are removed, overpopulation can happen at all the other levels. More animals at the bottom of the food chain means an increased number of the same types of animals competing for the same resources. In the Sahara Desert for example, the loss of the African lion and the African wild dog from this ecosystem means that the herbivore population is no longer regulated by these animals. Thus, a larger number of animals depend on the availability of already scarce resources such as plants and water.

Climate change is another driving factor in the loss of available resources in an ecosystem. Changing atmospheric conditions in terrestrial and marine environments alike are leading to increased bouts of extreme weather, such as droughts and floods. Animals that cannot adapt to a warming climate, such as corals, face extinction. The loss of one species can mean the collapse of an entire ecosystem.

Video Lesson 1

Quick Code: egst5118

Lesson 1

DIGITAL

Quick Code: egst5119

Student Page 73

Activity 1
Can You Explain?

10 min

What might happen to a food web when an organism or the environment changes within an ecosystem?

Instructional Purpose

In this activity, students communicate prior knowledge related to ecological factors that may affect food webs.

Scientific Context

Ecologists study ecosystems to understand the complex relationships that plants and animals have with the environment. Scientists use food webs to model interdependence. There are many factors that may affect the health of an ecosystem. Some examples are an overabundance or lack of specific organisms and environmental issues.

Life Skills **Endurance**

Strategy

Encourage students to explain what they already know about food webs. Challenge students to think about how a food web would be affected if changes occurred.

Direct students to look at the image and consider what would cause a lake and river to dry up. Use the following questions to elicit a brief discussion about the image.

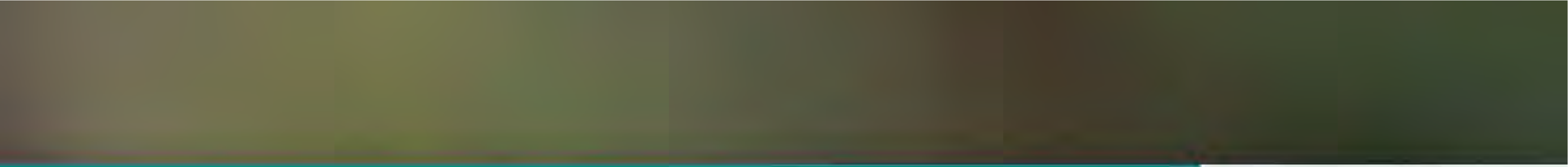
ASK

- *What do you notice in this image?*
  Answers may vary. Students may notice the dried ground and the evaporating water.
- *What might have happened to cause this lake and river to dry up?*
  Answers may vary. Students may mention a drought or the hot sun.

Display the Can You Explain? question so that all students can see it. Students may have some initial ideas about how to answer the question. Students should be able to construct a scientific explanation by the end of the concept. The explanation will include evidence from the concept activities. Keep in mind that students' answers may not be fully formed at this point in the concept.

Sample student responses shown.

What might happen to a food web when an organism or the environment changes within an ecosystem? Answers may vary. All organisms may be affected. Without enough producers, consumers may die or need to move. If there are too many of one species, resources like food may disappear.



Investigative Phenomenon

Activity 2
Ask Questions Like a Scientist

10 min

Protecting Ecosystems

Instructional Purpose

The Investigative Phenomenon is designed to ignite student curiosity about events in the world around them. In this activity, students generate questions about possible human impact on ocean life.

Scientific Context

Human activities affect marine habitats through overfishing, ocean pollution, the introduction of invasive species, as well as many other forms of impact. Consequences may not yet be known for some of the impact.

Life Skills **Critical Thinking**

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

Direct students to watch the video. Generate a discussion about coral reefs and ocean environments.

ASK

- *Can outside sources affect ocean ecosystems?*
  Answers may vary. Students may have knowledge of plastic or other waste affecting the ocean.
- *How do you think what is done on land might affect ocean life?*
  Answers may vary. Students may mention runoff or other land activities that could pollute ocean water.

Allow time for a brief discussion. Then, ask students to complete their own questions.

Sample student responses shown.

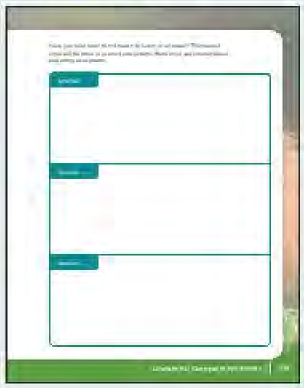
I wonder . . .	*Answers may vary. Why would what happens on land affect ocean life?*
I wonder . . .	*Answers may vary. Does what happens in the ocean affect land?*
I wonder . . .	*Answers may vary. How can fishing affect an ecosystem?*

DIGITAL

Quick Code: egst5120

Student Pages 74–75

Student Page 75



Lesson 1, *continued*

DIGITAL

Quick Code:
egst5121

Student Pages 76–77

Activity 3
Evaluate Like a Scientist

10 min

What Do you Already Know About How Food Webs Can Change?

Instructional Purpose

In this activity, students communicate prior knowledge related to events that may cause changes to food webs.

Scientific Context

Interactions between organisms are complex and multi-dimensional. Through the use of models, scientists can predict effects of changes that occur in a food web. Relationships between specific organisms play a large role in balancing an ecosystem as a whole. When organisms are removed or their role in a community changes, an entire ecosystem can collapse.

Life Skills **Critical Thinking**

If . . . Then

Strategy

The item If . . . Then provides a formative assessment of students' existing understandings of effects of changes within a food web. Use this assignment to assess what students already know about food webs within an ecosystem.

Sample student responses shown.

We know that sometimes ecosystems change. Does that mean food webs can change too? Think about what might affect an ecosystem and possibly a food web. Read the statement in the first column. Finish each statement in the next column with what might happen next. Write why you think these results might occur. Continue until you have completed each statement.

If there is a gentle rain in the desert,	*then the desert ecosystem might improve because rainwater will feed the plants and the producers will feed the organisms.*
If there is a heavy rain in the desert,	*then the desert ecosystem might be harmed because the water will cause flooding which will destroy the ecosystem.*

If there is a drought and all the grass dies,	*then the food web in the ecosystem might collapse because the plants will die and so will the organisms.*
If there are many top predators in the food web,	*then the organisms in the food web might be harmed because the top predators will eat all the organisms.*

Food Webs

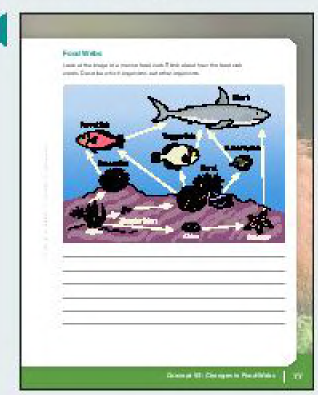
Strategy

The item Food Webs provides a formative assessment of students' existing knowledge of food webs and the role of different organisms. Use student answers to guide future discussions about food webs. Do not worry if students do not have a robust knowledge of the ocean/coral reef food web. Encourage students to use related knowledge and think about the main relationships between the producers (algae and diatoms) and the consumers shown.

Sample student responses shown.

Look at the image of a coral reef food web. Think about how the food web works. Describe which organisms eat other organisms. The algae produce their own food. The zooplankton, clam, and sea urchin eat the algae and diatoms. The sea star feeds on the clam. Coral feeds on zooplankton and is eaten by butterflyfish, triggerfish, and parrotfish. The shark eats these three different fish.

Student Page 77

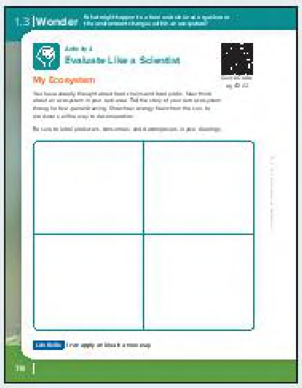


Lesson 1, *continued*

DIGITAL

Quick Code:
egst5122

Student Page 78



Activity 4
Evaluate Like a Scientist

15 min

My Ecosystem

Instructional Purpose

In this activity, students activate prior knowledge to identify a real-world example of a local ecosystem and its food web.

Scientific Context

Food webs help us understand the feeding relationships among species within a community. They reveal species interactions and community structure. Through these interactions, we are able to understand the dynamics of energy transfer in an ecosystem.

Life Skills **Creativity**

Strategy

Guide students to think about ecosystems within their own area. As a class, discuss an example of one ecosystem of which students are familiar. Together, list as many organisms as possible that live in that ecosystem. Then, ask small groups of students to use the organisms to show how energy in an ecosystem flows from the sun, to producers, all the way to decomposition.

Sample student responses shown.

You have already thought about food chains and food webs. Now think about an ecosystem in your own area. Tell the story of your own ecosystem through a four-panel drawing. Show how energy flows from the sun, to producers, all the way to decomposition. *Drawings will vary.*

Video Lesson 2

Quick Code: egst5123

Activity 5

Investigate Like a Scientist

30 min

Hands-On Investigation: Energy Flow Body Model Part 1: Pass It On

Instructional Purpose

In this activity, students model the flow of energy through a food web.

Scientific Context

A food web can describe how energy and nutrients move through an ecosystem. Plants produce the energy, then the energy moves up to higher-level organisms like herbivores. Energy is transferred from one to the other as carnivores eat the herbivores.

Life Skills **Creativity**

Activity Activator: Make a Prediction

Use this activity to provide students with a physical way to model an ecosystem. Paper squares are used as the energy currency that gets passed from one organism to another. Encourage students to think about how the materials provided can model energy flow in an ecosystem.

Sample student responses shown.

How can we use the materials provided to model energy flow in an ecosystem? Answers may vary. We can each become different types of organisms. The paper squares can be used to represent energy as it flows through an ecosystem.

After students have completed this activity, recap the flow of energy. Discuss with students the fact that unlike paper squares, which are physical matter, energy is not a form of matter, but rather an entirely different property that has no mass. Encourage students who are interested in this distinction to research the difference between matter and energy.

Consider using a food web from the previous lesson as the food web for this activity. Alternatively, prepare a simple illustration of a local food web that clearly outlines different relationships between producers, consumers, decomposers, and the sun. List each organism on a separate index card, until you have enough for all students to participate. You may list organisms more than once.

DIGITAL

Quick Code: egst5124

Student Pages 79–80

Materials List

(per group)

- Index cards labeled with organisms
- Picture of a food web
- Paper squares, 3 cm x 3 cm, 10 per student

Safety

- Follow all lab safety guidelines.
- Follow proper disposal and cleaning procedures after the lab.
- Be careful using sharp objects such as scissors.

Lesson 2, *continued*

Activity Procedure: What Will You Do?

1. Post a picture of a food web in a central location. Using index cards labeled with organisms from the food web, randomly assign students different animal roles to play.
2. Each student should receive 10 paper squares to represent their energy content.
3. Instruct students to play a walking game of predator-prey tag where they capture prey or evade predators according to the relationships in the posted food web.
4. If a student gets "captured," one of the paper squares is given to the predator and the captured student moves to the side of the activity (with their remaining squares) to watch the rest of the game.
5. Continue the game through decomposers.
6. When students are finished, compare the number of paper squares left in the game to the number of paper squares that have been removed from the game.
7. Lead a class discussion about the flow of energy through a food web as indicated by the flow of paper squares. As a class, come to a conclusion about why the sun is necessary for food webs to maintain themselves.
8. Explain to students that one-tenth of the energy of one organism moves to another organism, but that the other nine-tenths never leave the ecosystem. This energy is left to the decomposers. For a math extension, encourage students to model this using fraction or percentage representations.

Analysis and Conclusions: Think About the Activity

Allow students time to review what happened in the activity. Students should discuss questions that may have come up during the role play.

Sample student responses shown.

What is happening to the energy in this system? Answers may vary. The energy in the system remains the same. Although energy is transferred between living things, the majority of the energy is recycled by decomposers back into the system.

Where in this system are energy changes occurring? Answers may vary. Energy changes are occurring when a predator gains energy from the prey by consuming the prey. The energy in the overall system remains the same, but some of this energy transfers to the predator.

MISCONCEPTION

Students may believe that when one organism eats another organism, all energy is transferred to the consuming organism or that energy disappears when it is used by an organism. In fact, only about 10 percent of energy is transferred between organisms when one organism consumes another. When organisms "use" energy, it is converted to metabolic heat energy.

Review the term *consumer* to help students understand there are different levels of consumers, depending on where the organism is in the order of the food chain. Reinforce students' understanding of the number of organisms (and hence the amount of energy) necessary at each stage of a food chain for organisms higher on the food chain to have enough food energy to survive.

Student Page 80

DIGITAL

Quick Code:
egst5125

Student Pages 81–82

Student Page 82

Lesson 2, *continued*

Activity 6
Observe Like a Scientist

15 min

Desert Food Web

Instructional Purpose

Students have explored food chains and how food webs show multiple feeding relationships among organisms in an ecosystem. In this activity, students predict how removing producers in a food web would impact the flow of energy in an ecosystem.

Scientific Context

Food webs show how organisms are interdependent and can be used to predict what may happen when one piece of a food chain is changed. As one organism is reduced or removed, other organisms that consume the removed food source would eventually die.

Life Skills **Critical Thinking**

Strategy

Ask students to carefully observe the image Desert Food Web. Allow time for students to answer the student response items. Then, facilitate a discussion using the questions that follow.

Ask students to consider what other animals might be affected by the removal of any of the organisms in the food chain pictured.

DIFFERENTIATION

Advanced Learners

Direct students to research an ecosystem and create a food web that represents the interactions among its producers, consumers, and decomposers.

Sample student responses shown.

What would happen to the hare if all the grass were removed from the area? *The hare would not have any food, so it would die.*

What would happen to the eagle if all the grass were removed from the area? *At first, nothing would happen to the eagle. Then, when the hares die, the eagle will have less food.*

How does energy travel from the grass to the eagle? *The hare consumes the grass, and the energy travels to the hare. Then, the eagle consumes the hare, and the energy travels to the eagle.*

Video Lesson 3

Quick Code:
egst5126

Activity 7
Investigate Like a Scientist

25 min

Hands-On Investigation: Energy Flow Body Model Part 2: Pollution

Instructional Purpose

In this activity, students model how pollution can permeate a food web.

Scientific Context

Pollution gets into the food web by contaminating resources that plants or animals consume. Organisms come into contact with the toxin through direct or indirect exposure. Food may become scarce for another species when an animal dies because of exposure to a pollutant.

Life Skills **Endurance**

Activity Activator: Make a Prediction

Use this activity to extend students' modeling of an ecosystem to include the results of human impact on natural communities.

Remind students of the previous investigation, Energy Flow Body Model Part 1: Pass It On. Explain that students will once again use paper squares as the energy currency that gets passed from one organism to another.

Ask students to give an example of something that comes to mind when they hear the term *pollution*. Encourage students to discuss how pollution might affect their own health. Then, ask students to consider how pollution might affect other organisms within a food web.

Sample student responses shown.

How can pollution affect a food web? Answers may vary. Students may include ideas about food supply or habitat being negatively affected.

DIGITAL

Quick Code:
egst5127

Student Pages 83–84

Materials List

(per group)

- Index cards labeled with organisms
- Picture of a food web
- Paper squares, 3 cm x 3 cm, 10 per student

Safety

- Follow all lab safety guidelines.
- Follow proper disposal and cleaning procedures after the lab.
- Be careful using sharp objects such as scissors.

Lesson 3, *continued*

Activity Procedure: What Will You Do?

1. Post the food web picture used in the previous investigation, Energy Flow Body Model Part 1: Pass It On. Randomly assign students different animal roles to play using index cards.
2. Each student should receive 10 paper squares to represent their energy content.
3. Instruct students to play the walking game of predator-prey tag where they capture prey or evade predators according to the relationships in the posted food web.
4. Stop students midway through the first round of the game. Tell students there has been a fire nearby, bringing smoke and ashes to the area. One-fifth of the plants have been covered or destroyed. Take away one-fifth of the producers.
5. Continue another round of the game. What happens to the rest of the organisms?
6. The game can be played with other pollution interruptions. For example, an oil spill takes out many of the birds. Water pollution kills organisms drinking from the pond.
7. Lead a class discussion about the flow of energy through a food web as indicated by the flow of paper squares. Draw conclusions, as a class, about the effects of pollution on a food web.

Analysis and Conclusions: Think About the Activity

Allow students time to review what happened in the activity. Students should discuss questions that may have come up during the role play.

Sample student responses shown.

Student Page 84

What happens when smoke and ash cover an ecosystem? Answers may vary. The grasses are covered with ash or burned. The animals may have difficulty breathing.

How might pollution affect a food web? Answers may vary. If an animal is affected and dies, it affects all other levels of the food web.

Activity 8
Observe Like a Scientist

20 min

Population Changes

Instructional Purpose

Students explore how changes in the climate affect the population of a species.

Scientific Context

Many scientists consider climate change to be the biggest threat to ecosystems worldwide. Different species of animals respond uniquely to changes in the climate. Too much or too little water, extreme temperatures, and violent weather can be challenging for many organisms. Populations of different species interact for survival in an ecosystem. Therefore, changes in an ecosystem will affect all the populations that live in a community.

Life Skills **Critical Thinking**

Strategy

Interactives offer a low-pressure and engaging environment for students to explore and test ideas. If your students cannot access the interactive, text has been provided to support learning.

Ask students to define *climate*. Discuss how the word *climate* might be used when referring to an environment.

ASK *How might climate affect a population of organisms?*
Answers may vary. Some animals might die, while others might thrive in the new climate. Too many or too few of a type of organism can affect the whole ecosystem.

As a whole class, review the questions in the student book before participating in the activity. Students may respond to the questions either during the activity or upon completion of the activity.

If computers are available, arrange students in small groups and direct them to complete the interactive independently or in teams and record their data. If students do not have access to computers, project the interactive and ask for student volunteers to come up to the computer to complete the tasks in the activity. Allow time for students to complete the questions.

DIGITAL

Quick Code:
egst5128

Student Pages 85–86

Lesson 3, *continued*

Student Page 86

Sample student responses shown.

What does the phrase population change *mean? Population is the number of organisms of one type of species living in an area. Any increase or decrease in the number of these organisms is a population change.*

How can change in the climate affect the population of a species? The population of a species increases if the climate change is suitable. It decreases if the change is unsuitable. The organisms would either die or move to another place.

Why does change in the population of one species affect the population of other species? In an ecosystem, all species depend on other species for survival. An increase or decrease in one species will affect the population of other species, too.

Video Lesson 4

Quick Code:
egst5129

Activity 9
Analyze Like a Scientist

20 min

Habitat Loss

Instructional Purpose

In this activity, students obtain information from text to explain habitat loss as well as the impact it has on food webs.

Scientific Context

Habitats provide organisms with the resources that they need to survive. When habitats are destroyed or the quality is negatively impacted, various organisms may not be able to survive. As organisms are lost from the ecosystem, the flow of energy in the food web will be impacted.

Life Skills **Critical Thinking**

Strategy

Ask students to describe what is needed in a habitat for an organism to survive. Students should discuss the five basic needs of living things: air, food, water, shelter, and space.

Direct students to observe the two images Healthy Coral Reef and Coral Dying from Warm Temperatures.

ASK *What might result from the coral dying?*
Answers may vary. Organisms that eat the coral may need to move to another location, or they will not survive. The coral acts as a habitat for other organisms and without this habitat, the organisms that depend on the coral will not survive.

Allow several students to respond. Then, direct students to read the text describing habitat loss in a coral reef system and answer the questions.

Sample student responses shown.

Why are healthy habitats important to all organisms in a food web? Healthy habitats provide all the needs of the organisms that live there. When each species has what it needs to survive, there will always be adequate food for each organism in the food web.

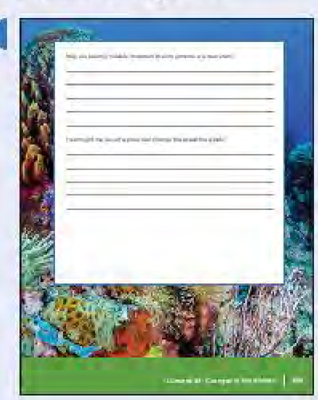
How might the loss of a coral reef change the ocean food web? Organisms that eat the coral will not have enough food and will not survive. Organisms that live in the coral will not have shelter and may not survive. Humans who rely on coral and fish for food can be negatively impacted.

DIGITAL

Quick Code:
egst5130

Student Pages 87–89

Student Page 89



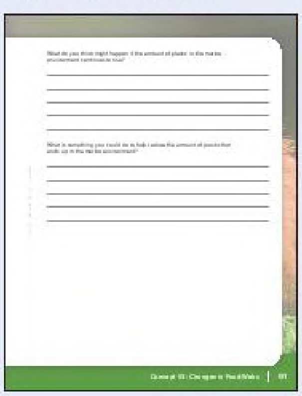
Lesson 4, *continued*

DIGITAL

Quick Code:
egst5131

Student Pages 90–91

Student Page 91



Activity 10
Analyze Like a Scientist

25 min

Plastic Pollution

Instructional Purpose

In this activity, students watch a video to obtain information about how plastics may enter the ocean and the effects the plastics have on the organisms in the ocean ecosystem.

Scientific Context

Human activity may negatively impact the environment. One example of negative impact is plastics that are found in the ocean. Oceans or seas are habitats that support a large variety of organisms. Organisms in the ocean often mistake plastic for food, causing great harm to ocean wildlife. As populations are reduced, the ocean food webs are disrupted, leading to a breakdown in the flow of energy.

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

After students read the text and watch the video, lead a class discussion about the impact of plastics in the ocean. Ask students to predict what would happen if the amount of plastic in the ocean continues to rise.

Sample student responses shown.

What do you think might happen if the amount of plastic in the ocean continues to rise? Answers may vary. Students should draw a conclusion that plastics will harm marine habitats and affect organisms that live in the sea or in the ocean.

What is something you could do to help reduce the amount of plastic that ends up in the ocean? Answers may vary. Students may suggest recycling or using less plastic.

Video Lesson 5

Quick Code:
egst5132

Activity 11
Evaluate Like a Scientist

45 min

Impact on a Food Web

Instructional Purpose

Students gather evidence from an image of a coral reef food web to further refine their understanding of how energy flow in an ecosystem can be disrupted by a change to any one part of the ecosystem.

Scientific Context

Coral is an important component of many ocean food webs. Coral serves as food for a variety of primary consumers. In addition, many organisms in the ocean use the coral as shelter. The loss of coral reefs has a devastating impact on the larger ocean ecosystem.

Life Skills **Critical Thinking**

Strategy

Ask students to look at the image Coral Reef Food Web.

ASK *What might happen to the ocean food web if the coral reef disappears?* *Answers may vary. Organisms that depend on coral for food and shelter die. The parrotfish, the triggerfish and the butterflyfish would have nothing to eat. When these animals died, the shark would have much less to eat and could die as well. The algae and plankton that live in the coral would lose their habitat.*

Facilitate a class discussion about the types of changes that could cause coral to be threatened. Changes may be a result of natural causes, such as extreme weather, or changes may be a result of human activities, such as pollution. Then, direct students to make a new drawing showing a change in the coral reef ecosystem. Student drawings should illustrate how the larger food web would be impacted when one part of it changes.

Sample student responses shown.

What happens if one part of the coral reef ecosystem changes? Make a new drawing that shows a change in your ecosystem. Show how the food web would be impacted. *Answers may vary.*

After students have completed their drawings, assign students into groups of three or four. Ask students to share their drawings with one another. Allow time for students to present and to ask questions about each other's drawings.

DIGITAL

Quick Code:
egst5133

Student Page 92

Video Lesson 6

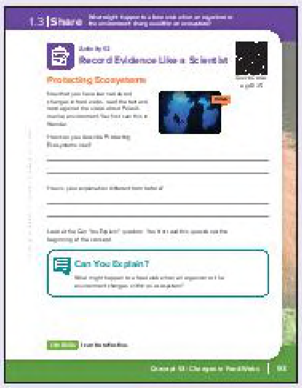
Quick Code:
egst5134

Lesson 6

DIGITAL

Quick Code:
egst5135

Student Pages 93–95



Activity 12

Record Evidence Like a Scientist

15 min

Protecting Ecosystems

Instructional Purpose

In this activity, students return to the questions posed at the beginning of the concept and reconsider what they know now. Students construct a scientific explanation about the Investigative Phenomenon Protecting Ecosystems and the Can You Explain? question.

Scientific Context

The process of writing a scientific explanation using evidence to support a claim is a key step in students constructing scientific knowledge that they can then use and apply.

Life Skills **Endurance**

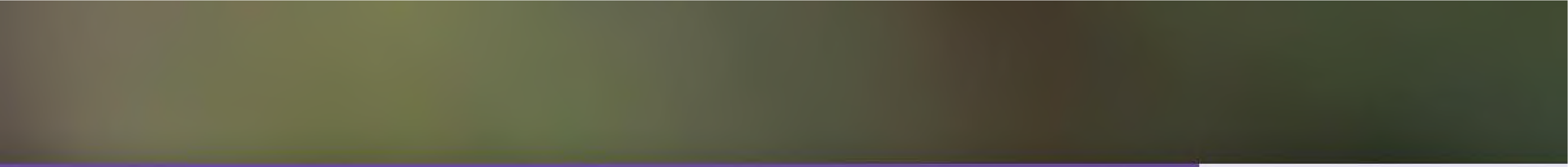
Strategy

Display the Investigative Phenomenon Protecting Ecosystems and the Can You Explain? question. Ask students to discuss and share with the class or a partner their explanation for the Investigative Phenomenon Protecting Ecosystems.

Sample student responses shown.

How can you describe Protecting Ecosystems now? Answers may vary. Students should reference the dependence of organisms within an ecosystem on one another. Students should also discuss how to protect ecosystems from changes that might affect one part of a food web, and therefore affect the entire system.

How is your explanation different from before? Answers may vary.



After allowing students to discuss,

ASK *How can this explanation help you answer the Can You Explain? question?*

Can You Explain?

What might happen to a food web when an organism or the environment changes within an ecosystem?

Students have already reviewed sample scientific explanations in earlier units, so they should be familiar with the process of using evidence to support a claim. You may want to review the following:

A **claim** is a one-sentence answer to the question you investigated. It answers, What can you conclude? It should not start with *yes* or *no*.

Sample student responses shown.

My claim: *All organisms may be affected by a change in a food web.*

Evidence must be:

- Sufficient—Use enough evidence to support the claim.
- Appropriate—Use data that support your claim. Leave out information that doesn't support the claim.

At this level, students should be able to construct a scientific explanation that includes reasoning as part of the explanation.

Reasoning ties together the claim and the evidence, and:

- Shows how or why the data count as evidence to support the claim.
- Provides the justification for why this evidence is important to this claim.
- Includes one or more scientific principles that are important to the claim and evidence.

Student Page 94

Lesson 6, *continued*

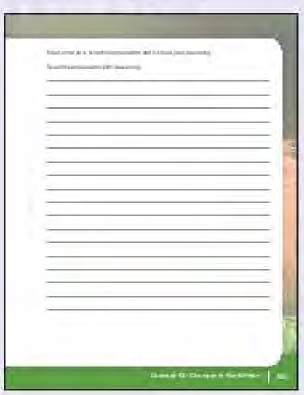
Sample student responses shown.

Evidence: *We learned that ecosystems are fragile and that all organisms play an important role in keeping the community in balance. When we modeled the transfer of energy in the energy flow activity, we saw that a small percentage of energy is passed with each interaction. When we then modified the ecosystem with pollution and other changes, the whole food web fell apart. When we looked at a desert food web, we found that if the grass (producers) are removed, even eagles who do not eat grass are affected. We read about how coral reefs impacted by pollution can cause an entire ecosystem to collapse.*

After providing scaffolding to students, allow them time to construct a full scientific explanation. Students can write, draw, or orally describe their claim, evidence, and scientific explanation that includes reasoning.

If time allows, invite students to share their claim, evidence, and scientific explanation with reasoning. Student answers in all sections will vary. Sample student answers are provided as a benchmark for possible responses.

Student Page 95



Sample student responses shown.

Scientific explanation with reasoning: *If there is a change in an ecosystem, all organisms may be affected. If there are not any producers, the consumers will need to move or will die themselves. If there are too many of one species, the resources may disappear. When this happens, other species may lose their food source and will not be able to survive. Nonliving factors may change, due to changing climate, pollution, or habitat loss. The organisms that live in the affected community may not be able to adjust to the new surroundings. When those organisms are no longer there, other populations may also decline. Everything in an ecosystem is connected.*

Teacher Reflection

- How did I provide scaffolding for students to construct their scientific explanations?
- How do I know my students are ready to apply the core content knowledge to another context?

Activity 13
Analyze Like a Scientist

20 min

Habitat Restoration

Instructional Purpose

In this activity, students read about a project to restore a coral reef that has been impacted by an increase in water temperature.

Scientific Context

Although human activities can negatively impact the environment, there are strategies that successfully restore habits, leading to a healthy and balanced ecosystem. Restoration projects also allow the opportunity for scientists to research better solutions for reducing the negative impact of human activities.

Strategy

As a class, read the text and watch the video about habitat restorations. Then, facilitate a class discussion to brainstorm other habitats that may be impacted by human activity. Ask students to think of ways people can prevent those habitats from being damaged.

Sample student responses shown.

Construct an argument for why habitat restoration projects are important. Use your understanding of ecosystem changes to support your argument. Then, suggest one way people in your community can help prevent damage to the environment. *Answers may vary. Habitat restoration projects help to prevent species from going extinct by restoring a habitat to the way it was before it was damaged. If the habitat is not restored, species may be lost, which may cause other populations to decline because they no longer have everything they need to survive. One way people can prevent damage to the environment before it happens is by keeping plastic and other pollution out of the ocean.*

DIGITAL

Quick Code: egst5136

Student Pages 96–97

Student Page 97

Lesson 6, *continued*

ENTREPRENEURSHIP

Encourage students to think about how the "zero plastics" policies might affect small business owners. How can entrepreneurs and small businesses balance the desire to protect the environment with the increased cost to change the way food is packaged, for example? Entrepreneurs and other business owners must be proactive, planning for the future by setting goals. Is protecting the environment a short-, medium- or long-term goal?

Review and Assess

Activity 14
Evaluate Like a Scientist

10 min

DIGITAL

Quick Code: egst5137

Student Page 98

Review: Changes in Food Webs

Instructional Purpose

The final activity in the concept asks students to summarize their learning by completing a series of assessment items.

Scientific Context

As part of the concept review, students reflect upon and synthesize knowledge acquired throughout the concept. This activity helps students practice sharing their scientific knowledge and findings with others and serves as a summative assessment.

Life Skills **Endurance**

Strategy

Now that students have achieved this concept's objectives, direct them to review the key ideas online. You may also assign students the summative assessment for this concept.

In the summative concept assessment, students support the argument that changes in one part of a food web impact other parts as well.

Sample student responses shown.

Write down some core ideas you have learned, specifically about the effects of changes in a food web. Are there any questions that you have now? Which of your questions require using scientific thinking or process? Are there any other skills or subjects that would be helpful (for example, art or math) to finding your answers? Answers may vary.

Teacher Reflection

- How many of my students met the performance expectation statements for this concept?
- For students who did not meet the performance expectations, what are my next steps?

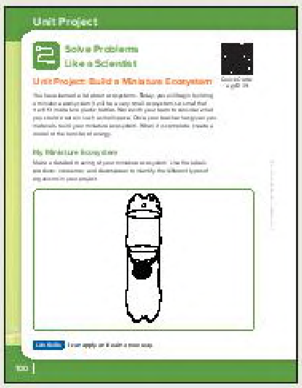
Video Lesson 7

Quick Code:
egst5138

DIGITAL

Quick Code:
egst5139

Student Pages 100–101



Unit Project

Solve Problems Like a Scientist

90 min

Unit Project: Build a Miniature Ecosystem

Instructional Purpose

The Unit Project allows students to return to the Anchor Phenomenon, Food Chains and Food Webs, and apply the performance expectations for the unit to solve or research a problem.

Scientific Context

In this activity, students build a miniature ecosystem using recycled bottles. Students will apply what they have learned about the parts of an ecosystem to plan, build, and explain their model.

Life Skills **Creativity**

Strategy

Students have learned about how living and nonliving components interact in an ecosystem. The Unit Project Build a Miniature Ecosystem is an opportunity for students to apply what they have learned in a hands-on project. If supplies are limited, projects can be very simple, including only nonliving items and producers. More complex projects may include small consumers and decomposers. This project can be planned and constructed over a series of days. Students can continue to observe and maintain their projects over a series of days or weeks, depending on classroom space and level of student interest.

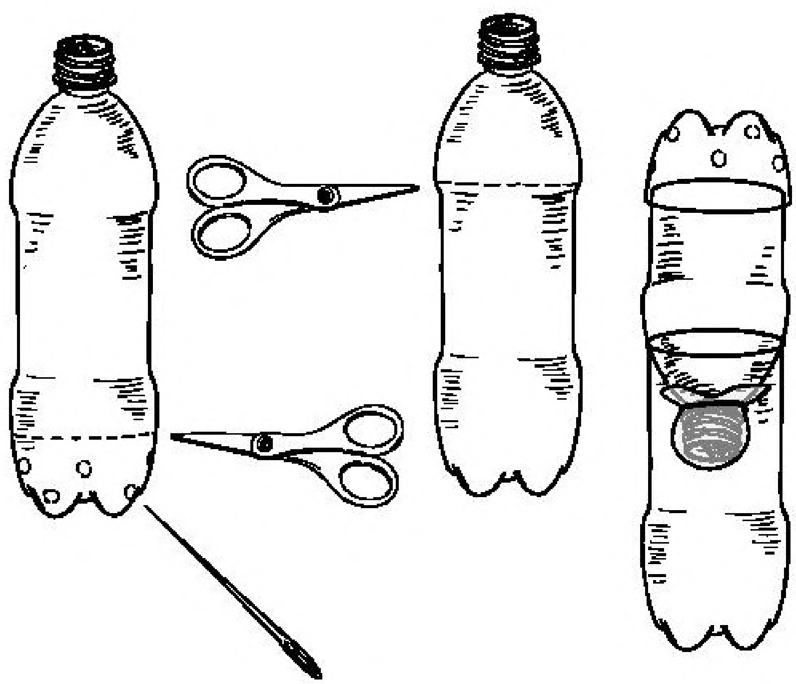
For a step-by-step guide to the construction of a simple miniature ecosystem, watch the Build a Miniature Ecosystem teacher instructional video.

To prepare for this project, ask students to collect large, empty plastic bottles, such as those that might have had soda or water in them. Students should clean the bottles with soap and water and rinse thoroughly, so that no residue remains.

Step 1: Preparation

Once the bottles have been collected, set aside class time to cut the bottles. Assign students into groups of three or four team members. Each group of students should have two large bottles, one marker, and a pair of scissors.

Demonstrate how to make lines for cutting on each bottle, following the diagram below. Each bottle should be cut once. Recycle the remaining pieces of bottle B, but retain both parts of bottle A. The bottom of the bottle that has been cut off will serve as a top for the terrarium. Once the bottles have been cut, students can invert bottle A and place it into bottle B. Bottle A will serve as the terrarium and bottle B will be the aquarium.

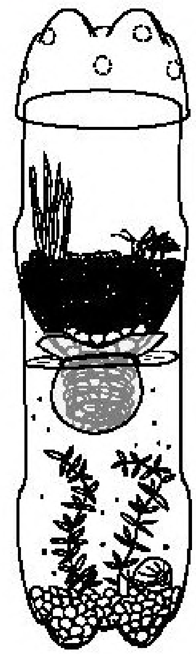


Step 2: Planning

Review the components of an ecosystem: nonliving items, producers, consumers, and decomposers. Provide each group with a large piece of paper and allow time for students to plan how they might build a miniature ecosystem in this container. Once groups have drawn and labelled their planning diagrams, call on each group to share their ideas with the class.

Step 3: Construction

Show students the materials that are available to them. Miniature ecosystems can be created in a variety of ways. Students can individualize their projects, but they should start with the basic construction detailed below.



Completed Miniature Ecosystem

On the first day of construction, plan to have students set up the nonliving materials and plant the seeds or introduce the plants that will form the base of the food chain in their miniature ecosystem.

Bottle B
Begin with bottle B. Place a shallow layer of rinsed gravel in the bottom of the bottle. Then, pour distilled water into the bottle, leaving room for bottle A to be inverted in the top. Place plants in the water or root them in the gravel.

Bottle A
Once the aquatic environment has been established, remove the lid from bottle A. Place a square of porous fabric over the opening and secure it with a rubber band. Invert bottle A into bottle B. (The water in bottle B should cover the opening of bottle A but not spill over the sides.) Next, place a layer of gravel into bottle A. On top of the gravel, place a layer of soil. Plant seeds or small plants in the soil. Finally, add some dead leaves or grass to one section of the terrarium.

Poke holes in bottle A and place the cut-off bottom of the bottle on top of bottle A to make a lid for the terrarium. Secure the entire column with strong tape. Do so in such a way that each piece can be removed and replaced as necessary.

Once the plants are established in the environment, other small organisms can be introduced. If starting from seeds, wait until the plants have begun to grow. Examples of terrestrial consumers that would be suitable include crickets or other small insects. Decomposers could include earthworms, isopods, or millipedes. In the aquarium, very small, plant-eating fish can be added as well as snails, who will serve as the decomposers.

Place the miniature ecosystems in indirect sunlight, where they can be observed periodically.

Step 4: Modeling

After the miniature ecosystems have been established, ask students to model the transfer of energy in their constructed environments. Students should draw one model for the terrarium and one for the aquarium. Remind students that energy flow begins with sunlight. All models should begin with energy from the sun. If students have only constructed ecosystems with nonliving items and producers, ask them to imagine what types of other organisms could be included in their projects. Students should include one possible consumer and decomposer in each of their energy transfer models.

Step 5: Observation

Students can continue to make observations and monitor the progress of their miniature ecosystems as long as the projects hold their interest. Further class discussions may include observation of changes in the system over time or movement of water within the environment. Because the bottles are not entirely sealed, water replacement may be necessary due to evaporation. Once the projects are no longer in use, disassemble the bottles, place living things in a suitable environment, and recycle plastic materials.

Sample student responses shown.

My Miniature Ecosystem

Answers may vary. Drawings of the miniature ecosystem should include the labels producers (plants), consumers (small animals that eat the plants), and decomposers (animals eating the dead leaves).

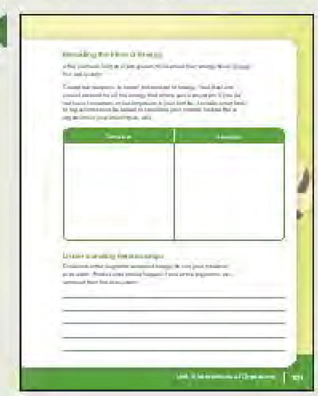
Modeling the Flow of Energy

Answers may vary. Students should draw two food chains (one terrestrial and one aquatic). Food chains should detail the flow of energy from the sun to producers, then to consumers, and onto decomposers.

Understanding Relationships

Answers may vary. I chose a food chain to show how energy flows through my miniature ecosystem. I developed this model by first identifying the types of living things that interact with each other in my ecosystem. Knowing that sunlight is the initial source of energy for an ecosystem, I used this as my starting point. After the energy from the sunlight was transferred to the producers, I used arrows to show how energy flows from one organism to another. Decomposers recycle energy back into the ecosystem, so I chose to end my model with an arrow from the decomposers back to the plants.

Student Page 101



Video Lesson 8

Quick Code:
egst5140

Lesson 8

DIGITAL

Quick Code:
egst5141

Student Pages 102–115


Interdisciplinary Project

Interdisciplinary Project: Waste Not, Want Not

Interdisciplinary Project

Solve Problems Like a Scientist

135 min

Interdisciplinary Project: Waste Not, Want Not

Instructional Purpose

The Interdisciplinary Project challenges students to use science, literacy, math, and design skills to find a solution to a real-world problem. This project addresses the worldwide problem of plastic pollution. Students will design and build a product using repurposed plastic.

Life Skills **Problem-Solving**

Project Overview

Each Interdisciplinary Project presents an opportunity for students to use the Engineering Design Process to design an original solution to the problem presented.

Interdisciplinary projects include a fictional story and informational text to set up a challenge and provide background. Then, students complete a multistep hands-on investigation. The project is best implemented over at least three lessons, but could be extended depending on student interest and time.

During the project Waste Not, Want Not, students design and build a product to repurpose plastic and materials otherwise considered trash. Students start by reading the fictional story. Following the story, students read an informational passage about plastic pollution in Egyptian waterways. Students examine the amount of plastic people use and discard. Then, students work in teams to consider the effect of plastic on the environment and come up with creative ways to repurpose plastic. Teams should share their process as well as their solutions.

Strategy

Prior to reading the text Waste Not, Want Not, ask students to think about times that they use plastic throughout the day. Remind students that a lot of common items are probably made of disposable plastics. Introduce the term *single-use plastics*, which refers to items that are designed to be used only once and then thrown away.

Post the following questions somewhere that all students can see them. Ask students to discuss the answers to these questions with a partner or in small groups. Once students have finished discussing, invite students to share their ideas with the class.

ASK

- *How do you use plastic in your day-to-day routine?*
  Answers will vary based on personal experience.
- *Once you are finished with these plastic items, what happens to them? Where does your trash go?*
  Answers will vary based on local community protocols, but students should have some knowledge of garbage disposal in their community.
- *What different things can you do with a plastic bag? What about a plastic bottle?*
  Answers will vary based on individual ideas. Encourage students to think creatively about innovative devices, art, and other possibilities for repurposing plastic.

Tell students that they are going to read a fictional story about four students who, while out along the Suez Canal, notice a lot of trash along shore and floating in the water. Read the STEM Solution Seekers story, Waste Not, Want Not to help students focus on the global problem of plastic pollution.

Encourage students to relate to the characters and situation in the story. Following the story, ask:

ASK

- *Have you ever been in a place and noticed plastic bags or bottles in the water?*
  Answers will vary based on personal experience.
- *What is wrong with having plastic in waterways?*
  Plastic pollution could harm wildlife and could affect the quality of the water. It also ruins the look of the landscape.
- *Why do you think the students in the story have different ideas on the best way to fix the problem of waste in the waterways?*
  There is not one single correct answer to the problem. It should be a combination of solutions that integrate reducing, reusing, repurposing, and recycling.

Divide students into groups of four. Instruct students to read the informational reading passage with their group. Once students finish reading, direct them to discuss key details from the text as well as the final two questions in the passage: *How could you reuse a plastic item in your home and turn it into something you could use again? What other problems could you help solve with your repurposed plastic item?*

Interdisciplinary Project, *continued*

Student Page 108


Interdisciplinary Project

Hands-On Investigation

Engineering Your Solution

Challenge

Objectives

Materials List
(per group)

- Plastic bottles or plastic bags
- Pencils
- Building materials, such as tape, glue, string, or construction paper
- Digital camera or digital video camera (optional)

Hands-On Investigation
Engineering Your Solution

Project Procedure

Prepare for the lesson by organizing a materials station with the items in the materials list. Decide whether or not students will be able to use tape, glue, string, construction paper, or other classroom resources in their designs and update the available materials list accordingly.

1. **Review the Challenge** Direct students to read the challenge description and objectives of the activity. Answer any questions students may have. Explain how teams will collaborate to repurpose plastic bags or plastic bottles into a new design. Challenge students to think of something that they could use in their everyday lives when deciding what to create. Direct teams to describe their design, explain how the prototype will work, and list the materials they used. Students should also record any problems they encounter while engineering and explain how they solved these problems.
2. **Assign Group Roles** Review each group role as a class. Then, support groups as needed while they discuss and choose roles for each member of the group. Direct every student in the group to record names in the Group Roles chart, so that groups can review the list at the beginning of each lesson. Remind students that every role is essential to the group's success.
3. **Sketch Ideas** Once students are in their teams of four, instruct students to individually sketch an idea for how they will turn their plastic bag or plastic bottle into something new. Encourage students to review the design process, think about the purpose of their repurposed object, and consider how they will know their design is successful. Remind students that design sketches should include labels or notes and do not need to be artistic. Groups should then review each member's sketches and decide on one design to fully develop. The questions provided below the sketching area support this discussion. To further support student groups in choosing a final design:

ASK
- *Does the design meet the requirements?*
- *Can teams build a prototype of the design?*

Consider the following discussion protocol for classes that are new to this type of collaboration:

- Two students in the group discuss which design they would select based on the given requirements and questions.
- While the pair is discussing, the other two members of the group actively listen.
- The listening pair can also jot down any ideas that they want to remember. After several minutes, have the two pairs switch roles.

4. **Plan and Build** Next, groups will plan and build their prototype.

    a. Provide each group with a piece of paper or small poster board. Direct students to draw a full diagram of the chosen solution with more details than the previous sketches. This diagram will be used as a blueprint, so remind students to label on the diagram the parts and materials they will use.

    b. Ensure that the team captain is keeping the group on task and keeping the designing on pace.

    c. Review and display the materials that are available to construct the projects. Adjust the items listed as needed based on the materials available. Before teams begin creating their agreed upon design, ensure that the recorder labels the materials teams will need on their final design sketch and explains how their new repurposed item will work in their plans.

    d. After groups review and discuss the materials they will need, the materials manager gathers materials, Direct groups to begin building their prototype. Remind students to keep track of the steps they have taken and their building process.

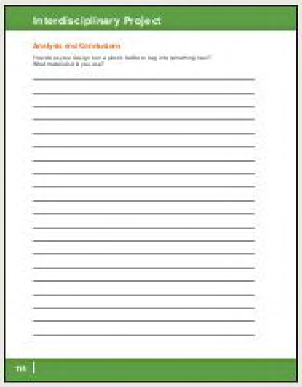
    e. As they work, ask students to document any problems they encounter, along with the solutions they use to solve the problems, in the Analysis and Conclusions section of their student investigation sheet.

5. **Reflect and Present** Once their project is finished, provide time for groups to discuss their results and determine if they met the challenge criteria using their observations.

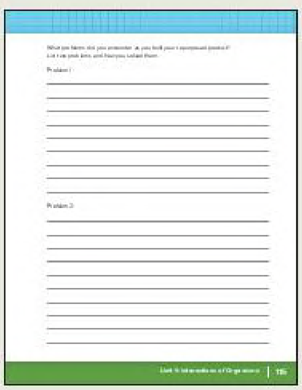
ASK

- *How could you improve your design?*
  Answers will vary.
- *How could your group improve how you worked together?*
  Answers will vary.

Student Pages 114–115


Interdisciplinary Project

Analysis and Conclusions



Analysis and Conclusions

After a brief initial reflection, direct groups to discuss the following questions. Each group member should record answers in their own words.

Sample student responses shown.

How does your design turn a plastic bottle or bag into something new? What materials did you use? Answers should describe a repurposed plastic bag or plastic bottle and how students changed it into something new. Teams should also describe the materials they used and how their repurposed item functions.

What problems did you encounter as you built your repurposed product? List two problems and how you solved them.
Problem 1: *Answers will vary but should include both a design problem and solution.*

Problem 2: *Answers will vary but should include both a design problem and solution.*

As time allows, have groups present their projects and reflections to the whole class or with one other group.

DIFFERENTIATION

Advanced Learners
If students are ready for an additional challenge, instruct their team to create a slogan for their new repurposed product that will teach others about what it does and why they would want to buy it. Students should write their slogan with a sketch of their final product on a poster to advertise their new design. If available in the classroom, groups can use a digital video recorder to create and film a commercial to go along with their poster.

UNIT
2 | Particles in Motion

Photo Credit: Tadja / Shutterstock.com

Theme 2 | Matter and Energy

Unit 2
Particles in Motion

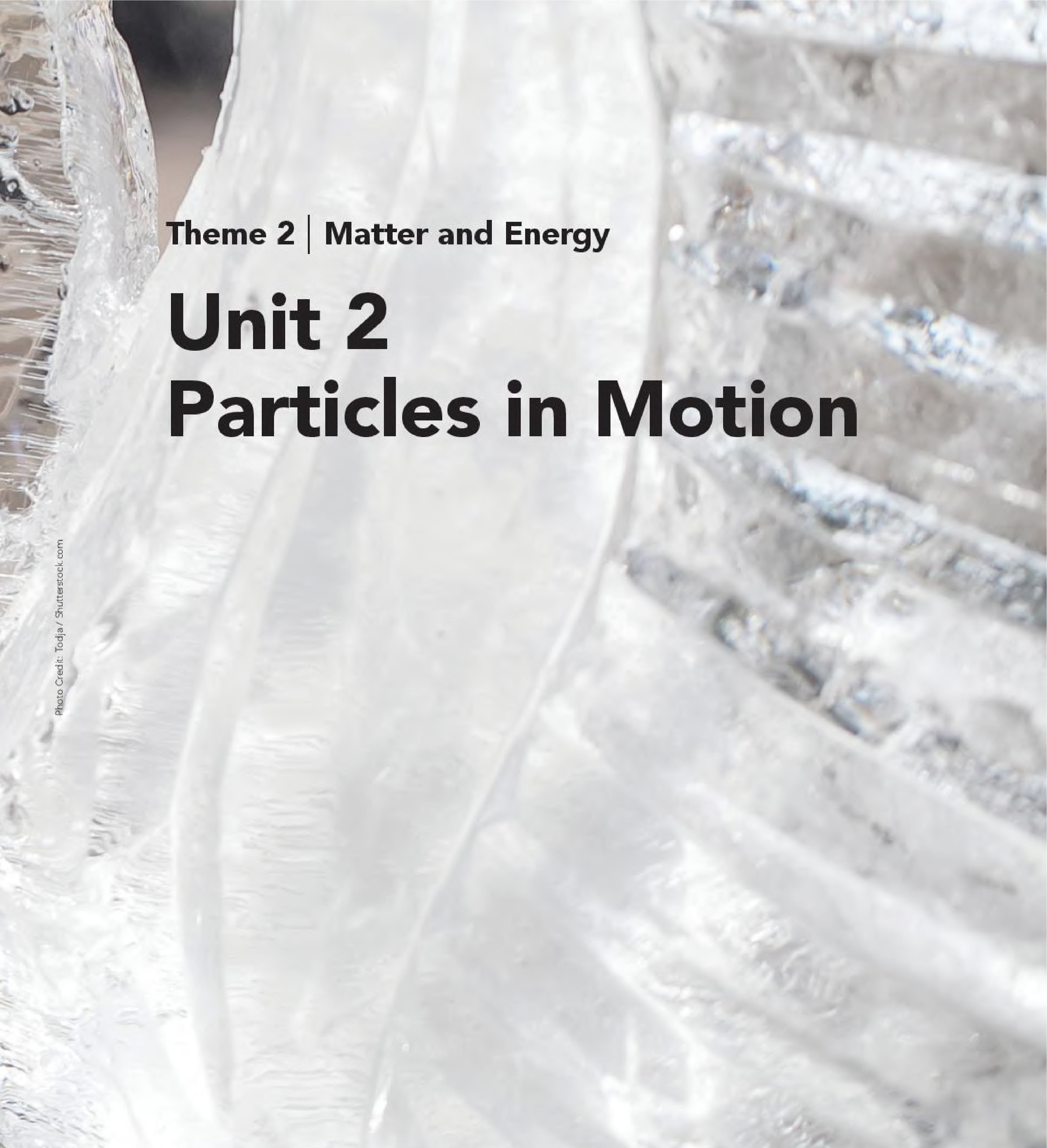


Photo Credit: Todja / Shutterstock.com

Learning Indicators

Throughout this unit, students will work toward the following learning indicators:

Primary 5 • CONCEPT	2.1	2.2	2.3
SCIENCE			
A. Skills and Processes			
1. Demonstrate thinking and acting inherent in the practice of science.			
a. Identify scientific and non-scientific questions.	●	●	●
b. Plan and carry out simple investigations to collaboratively produce and collect data that answers a question.	●	●	●
c. Organize simple data sets to reveal patterns that suggest relationships.	●	●	●
d. Construct an argument with evidence and data.	●	●	●
e. Identify limitations of models.	●	●	●
f. Use multiple sources to answer questions or explain phenomena.	●	●	●
g. Communicate scientific information orally and in written formats.	●	●	●
D. Physical Science			
1. Use scientific skills and processes to explain the interactions of matter and energy and the energy transformations that occur.			
a. Develop a model to describe that matter is made of particles too small to be seen. *[Examples of evidence supporting a model could include adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, and evaporating saltwater, not to be explained using atomic theory.]* 1) Describe the characteristics of a solid, liquid, and gas in terms of how the particles interact. 2) Compare the properties of solids, liquids, and gases (such as volume, shape, or mass). 3) Explain the role of increasing or decreasing heat on the states of matter.	●	●	●

	2.1	2.2	2.3
b. Make observations and measurements to identify materials based on their properties. *[Examples of materials to be identified could include baking soda and other powders, metals, minerals, and liquids. Examples of properties could include color, hardness, reflectivity, response to magnetic forces, and solubility; density is not intended as an identifiable property.]* 1) Classify materials based on physical properties, including shape, color, texture, or hardness, as well as physical state (solid, liquid, or gas). 2) Use appropriate tools to measure various properties (such as length, mass, or volume).	●	●	●
F. Engineering Design and Process			
1. Apply engineering design processes and understanding of the nature and characteristics of technology to solve problems.			
e. Generate and compare multiple solutions to problems based on how well they meet the criteria and constraints.			●
f. Assess the impact of products and systems.	●		●

Unit Outline

Anchor Phenomenon: Get Started

Sands of Time

As an introduction to the study of matter, students examine the movement of sand through an hourglass. Students should begin to ask questions about how sand behaves, what state of matter sand is, and how the properties of sand can be manipulated for practical application purposes.

Unit Project Preview

Slippery Sands

Students begin to think about sand as matter and consider how sand could be mixed with other elements to be used for a specific purpose.

Concepts

2.1 Matter in the World Around Us

Students learn that matter is composed of very small particles that behave differently in solid, liquid, or gas form.

2.2 Describing and Measuring Matter

Students learn that matter can be described and identified in a variety of ways.

2.3 Comparing Changes in Matter

Students learn that matter can change physically (by mixing or changing temperature and/or state) as well as chemically (when new substances are formed).

Unit Project

Slippery Sands

In this project, students consider the individual properties of sand, as well as how sand can behave in a mixture. Students investigate how sand can be changed into a material that can be used to reduce friction. Students propose hypotheses and test various ratios of sand and water in a mixture. Students use this mixture to explore a historical scenario as they investigate this question: How did the ancient Egyptians move large blocks of heavy stones to create the pyramids?

Unit Storyline

Children interact with matter in various forms and investigate changes daily, without ever knowing that they are engaging in scientific investigation. Reflecting on everyday experiences will help students start the second unit, Particles in Motion, from a place of familiarity and confidence. Students are given the opportunity to connect academic language to phenomena that they commonly experience in the real world. Students classify materials by state and learn how the characteristics of the particles in each form define how the matter behaves. Students build models to craft concrete representations of the highly abstract concept of particle arrangement and movement. Once students understand why solids, liquids, and gases each behave differently, they practice the scientific skills of describing matter according to properties, as well as quantifying matter with weight and measurement. Finally, students investigate the driving forces behind changing states of matter as they explore the effects of temperature on matter, as well as physical and chemical changes.

Unit 2 Introduction: Get Started

What I Already Know

The second unit in Primary 5 science focuses on matter and energy, drawing on the physical science ideas of particles in motion and changing states of matter. Students should be somewhat familiar with solid, liquid, and gas forms of water. This unit introduces the idea that all matter is composed of very small particles that behave differently depending on what state the substance is in. Students gain new ways to describe matter and build models to illustrate the arrangement and motion of particles. Students also observe and then analyze changes in matter, whether they are physical or chemical in nature.

Quick Code:
egst5173


Get Started

What I Already Know

You might not immediately think of a volcano when you hear the phrase *states of matter*. Look at the images. Think about what you know about gases, liquids, and solids. Can you find evidence of the different states of matter when observing a volcano?

Quick Code:
egs5173

Write about what you already know about the different states of matter. Use evidence from the different images of volcanoes provided.

Talk Together Where else can you easily observe different states of matter? Share with a partner about places in your home or school where you might observe solids, liquids, or gases.

During this unit, you will learn that matter is composed of very small particles that behave differently in solid, liquid or gas form. You will also learn more specific ways to identify, describe, and measure matter. You will learn that matter can change physically (mixing, temperature, and state) as well as chemically (new substances formed). Finally, you will bring together all of your knowledge and apply it to the Unit Project: Slippery Sands.

Unit 2: Particles in Motion | 117

The opening image is of a volcano, focusing on three different observable states of matter—gas, liquid, and solid. Typical examples illustrating states of matter use cooking, so if students struggle to connect with the volcano images, you may wish to show more familiar images of water boiling, sauce or juice being poured, and ice or other solid food items.

The first image shows gases and smoke escaping during a volcanic eruption. The second image shows lava in liquid form, pouring into liquid water. The final image shows solidified lava, also known as igneous rock. Ask students what other examples they are familiar with related to gases, liquids, and solids. Challenge students to think of other phenomena that illustrate the different states of matter.

After providing time for students to share ideas, instruct them to complete the activity.

Sample student responses shown.

Write about what you already know about the different states of matter. Use evidence from the different images of volcanoes provided. Answers may vary. Students should be able to describe differences among solids, liquids, and gases. Students should correctly identify the different states of matter shown in each of the images.

Anchor Phenomenon: Sands of Time

Shift the class discussion from the What I Already Know activity and ask students to watch the video about sand. Students will likely have vast amounts of personal experience with sand. Students can use this prior knowledge as a basis for considering sand in the context of studying matter. In the Anchor Phenomenon, students are asked to think about what they already know about the behavior and properties of sand. Students should begin to formulate questions about how sand reacts to movement, responds to change, and interacts with materials around it.

Video

Sand Poured from a Toy Truck

Unit Project Preview

Slippery Sands

Quick Code: egst5174

After completing the unit Particles in Motion, students should be familiar with the defining characteristics of solids, liquids, and gases. Students now understand how different states of matter behave and how matter can change state when energy is added or removed. Students have also investigated how materials can interact with one another in mixtures. In the Unit Project Slippery Sands, students apply what they have learned about matter and mixtures to further explore sand in the context of a real-world, engineering scenario.

Life Skills **Creativity**

Question

How did the ancient Egyptians move large blocks of heavy stones to create the pyramids?

CONCEPT

2.1

Matter in the World around Us

Concept Objectives

By the end of this concept, *students* should be able to:

- Communicate the defining characteristics of the three states of matter.
- Explain how changes in states of matter result in changes to the organization and movement of the particles within matter.
- Develop models of particles of matter in different states.

Quick Code: egst5032

Key Vocabulary

gas, liquid, mass, material, matter, model, particle, property, solid, state of matter

Quick Code: egst5033

Concept Pacing

Recommended Pathway

In order to meet the expectations of the standards, students must complete each activity within the recommended pathway.

Location	Days	Model Lesson	Time
Get Started		Get Started	10 min
Wonder	Lesson 1	Activity 1	5 min
		Activity 2	15 min
		Activity 3	15 min
Learn	Lesson 2	**Activity 5**	35 min
		Activity 6	10 min
	Lesson 3	Activity 7	20 min
		Activity 10	10 min
		Activity 11	15 min
	Lesson 4	Activity 12	20 min
		Activity 13	25 min
	Lesson 5	Activity 14	10 min
		Activity 15	35 min
Share	Lesson 6	Activity 17	25 min
		Activity 18	20 min

Bold activities are Hands-On Investigations. A full list of materials required, along with any additional preparation, can be found online.

Quick Code:
egst5034

Content Background

Children interact with matter in various forms and investigate changes without knowing that they are engaging in scientific investigation. Examples include hurrying to eat a popsicle before it melts, running a finger down the side of a cold glass as water droplets form, blowing on a hot cup of tea to cool it down or observing as rain puddles evaporate under the hot sun. Throughout the concept Matter in the World around Us, students are given the opportunity to connect academic language to phenomena that they commonly experience in the real world. Once a basis for understanding how to define the states of matter is established, students then begin building models to craft concrete representations of the highly abstract concept of particle arrangement and movement. By the end of the concept, students should have a thorough knowledge of the different states of matter and how they differ, which will assure student success when more complex material is introduced in subsequent activities and later grades.

States of Matter

Most matter on Earth is found in three states: solid, liquid, and gas. However, a fourth state—plasma—is common throughout the universe. Plasmas form when matter has enough energy for the electrons to break free from the rest of the atoms. Plasmas are found on Earth in fires. Because this state involves subatomic changes, it is difficult for children to comprehend and is not included for the elementary level.

Which state a material exists in—solid, liquid, or gas—depends on the arrangement of atoms or molecules. The particles that make up a solid are locked in place relative to one another. However, these particles vibrate in place. All matter above absolute zero has some motion. In liquids, the particles are held close together, but they are free to move past one another. In gases, the particles are farther apart and have little attraction to one another. Liquids and gases are both fluids because they can flow.

The unique arrangement and movement of the molecules in different states of matter is the reason that solids, liquids, and gases have characteristics that define them. Solids have a definite size and shape that they maintain unless broken. Liquids can be poured and take the shape of whatever container that they are placed in, while maintaining a definite volume. Gases fill the space of their container. They have no definite shape and do not have a fixed volume.

Properties of Matter

We interact with matter in the form of materials (water, air, fabrics) and objects (marbles, organisms, buildings). Typically, we characterize these materials and objects by describing their properties. Some common properties include size, shape, color, texture, temperature, and hardness. People commonly use relative terms to describe objects (large, cold, hot, small, rough). Scientists use exact measurements and clearly defined categories (such as temperature and a hardness scale). It is often important to quantify the amount of matter in a material or an object, and typically we measure the mass and/or volume. Understanding the basic characteristics of matter is a precursor to understanding how it can change. Students learn that the same type of matter can have different properties, even though its mass remains constant unless we add or take away matter. Its volume, however, may change as it goes through a change of state. At this age, we do not typically explain conservation of mass at the atomic level, but some students may be able to understand that the mass remains the same because the number of molecules does not change when the material changes state.

Video Lesson 1

Quick Code:
egst5036

Lesson 1

DIGITAL

Quick Code:
egst5035

Student Page 121

Activity 1
Can You Explain?

5 min

What are the different forms of matter that can be found in the world around us?

Instructional Purpose

In this activity, students communicate what they know about the types of matter by examining an image of a landscape and describing the different forms of matter that they can identify.

Scientific Context

Scientists study matter to learn more about the world around them. It is important for scientists to know the properties of matter because all things are made up of matter. Each type of matter has different physical characteristics, and scientists need to know and understand these characteristics.

Life Skills **Endurance**

Strategy

Ask students to look at the image. Encourage students to think about the different types of matter in the image. Challenge students to think about what forms matter takes in their everyday lives.

Instruct students to record what they already know about the types of matter.

ASK *What are the different forms of matter that can be found in the world around us?*
Answers may vary. Students may recall forms of matter from previous learning and will likely mention solid, liquid, and gas.

Students may have some initial ideas about how to answer the question to identify the types of matter. By the end of the concept, students should be able to construct a scientific explanation, which includes evidence from the concept activities.

Sample student responses shown.

What are the different forms of matter that can be found in the world around us? Answers may vary. Matter is anything in our world that takes up space. Matter can be in the form of a solid, liquid, or gas.

Investigative Phenomenon

Activity 2
Ask Questions Like a Scientist

15 min

States of Water

Instructional Purpose

The Investigative Phenomenon is designed to ignite student curiosity about events in the world around them. In this activity, students make observations and describe the difference between states of matter in three different photographs.

Scientific Context

Each state of matter has different properties. Students will use their understanding of the states of matter throughout subsequent lessons and when completing the unit project.

Life Skills **Critical Thinking**

Strategy

Provide time for students to individually observe the three images of water in different states of matter. Access students' prior knowledge by asking them to turn and talk with a partner about their observations.

ASK

- *What is the same in the images?*
  All of the images are of water.
- *What is different?*
  The water looks and behaves differently in each picture. The water is in a different state in each photo.
- *When have you seen water in these states of matter before?*
  Answers may vary. I have seen ice cubes in a cold drink. I see water flowing out of the tap. When my mom makes tea, steam comes out of the kettle.

Ask student pairs to volunteer to share what they discussed with the whole class.

DIGITAL

Quick Code: egst5037

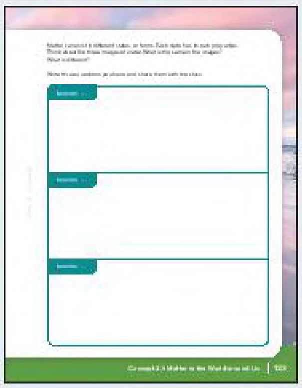
Student Pages 122–123

Lesson 1, *continued*

Provide time for students to make "I wonder" statements about the states of matter. For example: I wonder how water changes into different shapes. I wonder if water can change back into the shape it once was.

As you complete the activities in Learn, students should look for evidence to answer their questions.

Student Page 123



Sample student responses shown.

I wonder . . .	*Answers may vary. How does water change into different shapes?*
I wonder . . .	*Answers may vary. Can frozen water or steam change back into the form it once was?*
I wonder . . .	*Answers may vary. Can my cup of orange juice change form too?*

DIFFERENTIATION

Approaching Learners
Students might not recognize steam as a form of water. Make connections to when students have seen a kettle on the stove, boiled a pot of water, or had a mug of tea. If time allows, safely allow students to observe a mug of hot liquid to watch the steam rise from it.

Teacher Reflection

- Did this activity engage students?
- Did this activity allow students to generate their own questions?
- Would I introduce the concept of different states of matter differently next year?

Activate Prior Knowledge

Activity 3
Observe Like a Scientist

15 min

More About Matter

Instructional Purpose

In this activity, students observe ways matter can be described.

Scientific Context

Noting the differences in the way matter can be described helps students better understand the defining properties of various states of matter. Properties are the traits that describe matter, such as color, shape, volume, and density.

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning

Direct students to read the text and watch the video Properties of Matter to observe examples of how matter can be described. Afterward, ask students to discuss ways to describe matter using their senses.

If time allows, provide additional opportunities to practice describing matter using a mystery object. In advance, select an object in the classroom. Tell students that they have 20 questions to ask about the properties of a mystery object in the classroom. Your answer can only be *yes* or *no*. For example, students may ask: Is it a solid? Is it yellow? Is it soft? Once students have asked enough questions to identify the object, call on students to make a guess as to the identity of the item. Probe for further information about which properties of the item revealed the identity.

Digital Extension Activity 4
Evaluate Like a Scientist

10 min

What Do You Already Know About Matter in the World around Us?

Use this online extension activity to extend student exploration.

Quick Code:
egst5039

DIGITAL

Quick Code:
egst5038

Student Page 124

Video Lesson 2

Quick Code: egst5041

Lesson 2

DIGITAL

Quick Code: egst5040

Student Pages 125–127

Materials List
(per group)

- Three opaque containers labeled A, B, and C
- A solid object
- A liquid
- Representation of a gas (See Teacher Preparation for further information.)

Safety

- Follow all lab safety guidelines.
- Follow proper disposal and cleaning procedures after the lab.
- Clean up any spills immediately.

Activity 5
Investigate Like a Scientist

35 min

Hands-On Investigation: Observing Matter

Instructional Purpose

In this activity, students observe a variety of materials and record what they think are the defining characteristics of solids, liquids, and gases. Encourage students to notice and describe the differences they observe and consider what is unique about each state.

Scientific Context

Our world is filled with solids, liquids, and gases, in addition to other matter that can go from one state of matter to another without changing its chemical substance. Students should know that each state has a different ability to store heat and that changing between states requires the involvement of energy.

Teacher Preparation

Before class, label the containers and place solids in containers labeled A, liquids in containers labeled B, and gases in containers labeled C. In container C, you may choose to place a photograph of something that represents a gas or leave the container empty, with only air inside. Place the three containers at each group's table.

To represent gas, you may choose to place an object that is filled with air into the container. Items such as a small square of bubble wrap or an inflated balloon can spark a discussion about the properties of the gas contained within the object. Alternatively, you may choose to use an image of a gas, such as steam from a kettle or gas bubbles in a soda. As a final option, you may elect to leave the container empty and use the absence of an item in the container to prompt a discussion about the nature of air that is all around us.

Activity Activator: Make a Prediction

In this activity, students will investigate solids, liquids, and gases. Organize students into small groups and provide them with the activity materials. Students can gently shake the containers to make their predictions. Once groups make their predictions, students can open the containers to observe what is inside. If you chose to leave container C empty, when students open this container, remind them to think about what state of matter is all around us all the time.

Before students investigate, facilitate a discussion with the following questions:

ASK

- *How are solids, liquids, and gases different?*
  Answers may vary. Students may have some knowledge of the properties of each state, such as that a liquid can be poured but a solid cannot.
- *What do you think is in containers A, B, and C?*
  Answers may vary.

Before students begin the investigation, ask them to record their predictions in Make a Prediction.

Sample student responses shown.

What do you think is in containers A, B, and C? Answers may vary. I think container A contains a solid, B contains a liquid, and C contains a gas.

Activity Procedure: What Will You Do?

Review the following procedures with the class. While groups are working, pose the following questions: How would you describe the properties of matter? How are the items alike or different?

1. Direct students to open the container labeled A and observe the properties of the object.
2. Students record their observations (such as color, size, shape, and texture) in the table.
3. Students decide if the object is a solid, liquid, or gas and record their decision in the table.
4. Students repeat the process for containers B and C.

Lesson 2, *continued*

Student Page 127

Analysis and Conclusions: Think About the Activity

Sample student responses shown.

How can you describe a solid? Answers may vary. Solids have a definite shape, can have different textures, and take up space.

How can you describe a liquid? Answers may vary. A liquid takes the space of its container, takes up space, and can be wet.

How can you describe a gas? Answers may vary. Gases are invisible, have no shape, and can be all around us.

How are solids and liquids alike? Answers may vary. Solids and liquids both take up space.

If a gas is invisible, what are some ways we know it is there? Answers may vary. We can see air move when the wind blows objects around, and we can see a balloon get larger when we blow air into it.

DIFFERENTIATION

Advanced Learners
For advanced learners, challenge students to describe an object in the room using its properties. Then, have students trade descriptions with a partner and see if they can correctly identify the object.

MISCONCEPTIONS

- Students may think that materials can only have properties of one state of matter.
- Students may think that steam is hot air instead of water vapor.
- Students may think that only water can melt, boil, or freeze.

Teacher Reflection

- Can my students identify properties of solids, liquids, and gases?
- What properties did my students struggle with during the investigation?

Activity 6
Analyze Like a Scientist

10 min

Matter

Instructional Purpose

In this activity, students identify evidence from scientific text to support the claim that particles are the building blocks of matter. Students will begin recording observations in a K-W-L chart that can be used throughout the unit.

Scientific Context

All matter is made of moving particles. How much these particles are moving determines the state of matter.

Strategy

Before students begin the reading, create a K-W-L chart as a class that can guide students as they read and think about this unit. Label the chart with the Can You Explain? question: What are the different forms of matter that can be found in the world around us?

Discuss this question, and record on the chart what students already know about matter and what questions they may have. Leave the third column blank to fill in after students read and learn throughout the unit.

Direct students to read the text describing matter and its three states with a partner. Instruct students to discuss new vocabulary with their reading partner as it comes up throughout the text. Students should highlight evidence that they can use to support a response to the Can You Explain? question.

After reading, discuss and record the evidence that students located and any additional responses on the K-W-L. It is likely that students may have questions about sections of the text, especially the section describing the particle movement in solids, liquids, and gases. Displaying this chart will help students organize these questions as they complete the remaining activities in the unit.

ASK

- *What evidence did you highlight in this article?*
  Common states of matter are solid, liquid, and gas. In solid matter, the particles are packed tightly and move only a little bit. In liquid matter, the particles have more space, have more energy, and move more freely. In a gas, the particles have a lot of space and energy and move very freely.
- *What questions do you have?*
  Student questions may vary.

DIGITAL

Quick Code:
egst5042

Student Pages 128–129


Activity 6
Analyze Like a Scientist
Matter

Lesson 3

Video Lesson 3

Quick Code:
egst5044

DIGITAL

Quick Code:
egst5043

Student Page 130

Activity 7
Observe Like a Scientist

20 min

States of Matter

Instructional Purpose

In this activity, students look for specific evidence in a video and text to help them explain the unique characteristics of different states of matter.

Scientific Context

Each of the three states of matter has defining characteristics. Observing how material behaves (for example, if it can be poured) can help determine the state of matter.

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

Students will begin formulating a definition of matter.

1. Direct students to move into small groups of three or four students each.
2. Provide each group with large paper or a sheet of chart paper. Ask groups to write the word *matter* in the center of the paper and to add notes around the word as they share with each other what they already know about matter.
3. Play the video States of Matter. Once the video is complete, ask students to read the text States of Matter. Direct groups to look for evidence to define the word *matter*.
4. Allow time for groups to add notes to their chart paper to finalize their definitions.

Digital Extension Activity 8
Observe Like a Scientist

20 min

Three States of Matter

Use this online extension activity to extend student exploration.

Quick Code:
egst5045

Digital Extension Activity 9

Evaluate Like a Scientist

10 min

What Form Is It?

Use this online extension activity to extend student exploration.

Quick Code: egst5046

Activity 10

Observe Like a Scientist

10 min

What Is Matter?

Instructional Purpose

In this activity, students identify evidence from scientific text to support the claim that particles are the building blocks of matter.

Scientific Context

Particles known as molecules make up all matter, but they are invisible to the human eye. In this activity, students are asked to consider how to gather data about these particles when they are seemingly not observable.

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

Assign students to watch the video and read the text What Is Matter? As students view the video and read the text, direct them to take notes, gathering evidence they can use to support the Can You Explain? question.

Ask students to discuss with a partner why we cannot see the individual particles that compose matter. Then, direct partners to discuss what data they could collect to establish that matter exists even when it is unobservable by the human eye.

DIGITAL

Quick Code: egst5048

Student Page 131


Evaluate Like a Scientist
What Form Is It?
Observe Like a Scientist
What Is Matter?

Lesson 3, *continued*

DIGITAL

Quick Code:
egst5049

Student Pages 132–133

Activity 11
Analyze Like a Scientist

15 min

Particles of Matter

Instructional Purpose

In this activity, students gather evidence to support a claim that particles are the building blocks of matter by reading an informational text.

Scientific Context

States of matter depend on the arrangement of particles in a substance. The particles that make up a solid are locked in place and closely packed with one another. In liquids, the particles are held close together but move freely. In gases, the particles are farther apart and have little attraction to one another.

Strategy

Read aloud or ask students to partner-read the text describing the composition of matter.

Before reading, share with students the claim that particles are often called "the building blocks of matter." Ask students to discuss what they think this means with their partner. If needed, encourage students to demonstrate the meaning through pictures, words, or acting it out.

DIFFERENTIATION

Approaching Learners
Break the reading into one-paragraph chunks and read each paragraph together as a class. Facilitate a class discussion after each paragraph and check for understanding by asking questions about the content. Prompt students to locate and highlight the answers in the text.

MISCONCEPTION

Students often find it challenging to understand just how small the particles that make up matter actually are. (At this stage, while students may have heard the term *molecules,* instruction will focus on the idea of particles rather than emphasizing atoms and molecules.) A common misconception is that cells and other microscopic objects are comparable in size to these basic particles. In fact, cells contain millions of molecules or particles.

Video Lesson 4

Quick Code: egst5047

Activity 12
Evaluate Like a Scientist

20 min

Modeling the Particles of Matter

Instructional Purpose

In this activity, students summarize their learning from previous activities and use evidence to identify the strengths of various models for the real-world scenario of melting ice cubes.

Scientific Context

Models provide representations of scientific concepts that can make abstract ideas more concrete. Objects that are either too small or too large to be effectively observed in their natural form are often easier to study when a model is used.

Strategy

To evaluate students' understanding of the previous activities, ask students to respond to the following scenario: You and a friend are playing with ice cubes outside on a hot summer day. You are both called away to do a chore and forget to clean up. Several ice cubes are left on a table outside in the sun. When you return several hours later, there are no ice cubes or water left on the table and your friend is puzzled and worried. What happened to the ice cubes?

1. Ask students to write a note to the friend explaining what happened to the ice cubes. The note should include the following terms: *matter, particle, solid, liquid,* and *gas.*
2. After constructing their explanation, have students complete the item Modeling the Particles of Matter. Use the item to help students explore the concept that matter is made of particles too small to be seen.
3. After students have completed the item, direct them to form small groups and ask them to explain why ping pong balls would be better models than syrup, pieces of paper, or a rainbow (spectrum). Students should begin to understand that the particles that make up matter are discrete, three-dimensional units.

DIGITAL

Quick Code: egst5050

Student Page 134

Lesson 4, *continued*

Sample student responses shown.

What happened to the ice cubes? Answers may vary. When we left, the ice cubes were solid. The sun heated up the ice cubes, and as the particles started moving faster, the solid cubes turned to liquid. The sun continued to heat up the particles, and the liquid evaporated.

Your student group is developing a model to show how particles make up matter. Your job is to choose an object to represent particles in the model. Which object will you choose? B. ping pong balls

Now, explain why you chose the object you did. Answers may vary. I chose ping pong balls because they are three dimensional, unlike paper or a rainbow. Also, they are easily separated, unlike syrup.

Activity 13
Analyze Like a Scientist

25 min

Tiny Particle Size

Instructional Purpose

In this activity, students identify evidence from scientific text and observations of blood cells to support the explanation that small scale particles make up matter.

Scientific Context

Students at this level are not expected to understand molecules and atoms. However, students should know that all matter is composed of particles that are too small to observe. This understanding is critical to helping students explain the observable phenomenon of the three states of matter.

Strategy

Instruct students to read the text that explains the extremely small size of particles that make up matter. Model for students how to take notes from the text to add to their collection of evidence in support of the Can You Explain? question: What are the different forms of matter that can be found in the world around us?

Before students begin reading:

ASK

- *What is the largest object you have ever seen?*
  Answers may vary.
- *What is the smallest object you have ever seen?*
  Answers may vary.
- *Have you ever used technology to help you see a large or small object?*
  Answers may vary. Some students may have experience using a microscope or magnifying glass to see small objects.

Use Think-Pair-Share for students to share their experiences observing large and small objects.

Allow students to read the text. If you have a class set of hand lenses, distribute them to students when they have completed the reading. If you have a microscope, display that as well. Discuss the practicality of a hand lens and microscope for seeing small and extremely small objects. Reinforce the concept developed in the text about the inadequacy of even a classroom microscope for viewing individual particles that make up matter.

DIGITAL

Quick Code:
egst5052

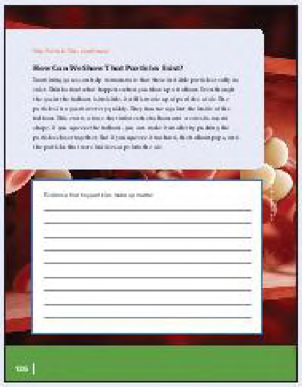
Student Pages 135–136


Analyze Like a Scientist
Tiny Particle Size
Tiny Particle Size
Tiny Particles
How Can We See Such Particles?

Lesson 4, *continued*

Display the image of blood cells and explain that a tiny blood cell can be seen under the high power of a microscope. Each of these blood cells is made up of about 100 trillion particles. Write the number 100,000,000,000,000 on the board to allow students to see the scale of each cell.

Student Page 136



Sample student responses shown.

Evidence that tiny particles make up matter: Answers may vary. Particles of gas are too tiny to see, but they move quickly. Particles in a balloon exert a force.

MISCONCEPTION

Some students may think that gases are not matter because they are invisible. This misconception may make students think that gases do not have mass or take up space. However, gases are matter because they have mass and take up space.

Video Lesson 5

Quick Code: egst5051

DIGITAL

Quick Code: egst5053

Student Pages 137–138

Activity 14

Observe Like a Scientist

10 min

Models

Instructional Purpose

In this activity, students learn how models can be used to represent phenomena and generate testable questions to analyze the model of a globe.

Scientific Context

Building models helps students understand unfamiliar objects, systems, processes, and phenomena. As students progress, they will be able to conceptualize and utilize a particle model of matter to help them better understand the properties and behavior of matter.

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

In this activity, students will be exposed to a variety of models. The purpose of this part of the lesson is to introduce and reinforce the concept of models to students. Students should understand and appreciate the value of models, not just for play (toy cars or dolls) but also for learning about unfamiliar objects, systems, processes, and phenomena. This understanding will reinforce students' understanding of a particle model of matter.

Display a globe and ask students what it is and how it can be useful. After students have participated in this discussion:

ASK

- *How is a globe like the real Earth?*
  Answers may vary. A globe shows the land and bodies of water that exist on Earth.
- *How is a globe different from the real Earth?*
  Answers may vary. A globe is much smaller than the real Earth.
- *How do scientists use models?*
  Answers may vary. Scientists use models to study phenomena that may be difficult to observe directly.

Direct students to watch the video and read the text.

Once students have finished, facilitate a class discussion using the prompt in the Talk Together box. Allow students to share personal experiences with using models.

DIGITAL

Quick Code:
egst5055

Student Pages 139–141

Materials List
(per group)

- Small buttons, beans, or other circular objects, about 40
- Glue
- Index cards or pieces of cardboard, 3, 10 x 15 cm or larger
- Markers

Safety

- Follow all lab safety guidelines.
- Follow proper disposal and cleaning procedures after the lab.
- Clean up any spills immediately.

Activity 15
Investigate Like a Scientist

35 min

Hands-On Investigation: Modeling States of Matter

Instructional Purpose

In this activity, students develop a model to represent the different states of matter: solid, liquid, and gas.

Scientific Context

Students will gain experience creating a model that describes the arrangement and movement of particles in a substance. The model can be used to explain the physical properties of solids, liquids, and gases.

Life Skills **Creativity**

Activity Activator: Make a Prediction

Students will develop an understanding of the arrangement of particles that are often too small to see but still exist.

In Part 1 of this Hands-On Investigation, students focus on creating a physical model of the spatial arrangement of the particles in the three states of matter. In Part 2, you will lead students in a discussion about the different motion of the particles in the three states.

To introduce this activity, arrange students into small groups and ask them to create a list of a few common solids, liquids, and gases. Encourage students to work together to discuss the general properties of each example they come up with. Probe students' understanding of the particle nature of matter and of the microscopic differences between solids, liquids, and gases. Discuss these topics with them and review, as appropriate, some of the basics of the concepts.

Consider discussing the following: All matter is composed of extremely small particles that are too small to see. The particles in a solid are tightly packed and arranged in a regular pattern; they move around or vibrate on the spot. The particles in a liquid are also close together but have a random arrangement; they move and slide around each other. The particles in a gas are far apart and have a random arrangement also; they move around quickly in all directions.

Because students will not be able to model the motion of the particles in this investigation, you should discuss this shortcoming during Part 2.

Sample student responses shown.

How will you use the materials to model the different arrangements of particles in each state of matter? To show the particles in a solid, I will arrange the beads neatly and close together. To show particles in a liquid, I will glue the beads so that there is space between them, but they are still somewhat close together. To show particles in a gas, I will glue the beads so that it looks like they are floating away from one another, with lots of space in between each bead.

Activity Procedure: What Will You Do?

Part 1: Modeling Solids, Liquids, and Gases

1. Ask students to use a marker to label one index card (or piece of cardboard): "Solid."
2. Explain to students that they will be creating a model of how particles in solids are arranged (tightly packed and organized).
3. Direct students to glue the buttons or seeds to the index card to create a model of a solid.
4. Ask students to use a marker to label another index card: "Liquid."
5. Explain to students that, on the second card, they will be creating a model of how particles in liquids are arranged (farther apart and less organized than in a solid).
6. Direct students to glue the buttons or seeds to the index card to create a model of a liquid.
7. Ask students to use a marker to label the final index card: "Gas."
8. Explain to students that, on the final card, they will be creating a model of how particles in gases are arranged (farther apart and even less organized than a liquid).
9. Direct students to glue the buttons or seeds to the index card to create a model of a gas.

Part 2: Discussion

1. When students have completed their models and cleaned up, divide them into pairs and have them discuss their particle models using the Think-Pair-Share strategy. Explain to students they will first think on their own about how particles are arranged in each state of matter. Then, students will discuss their models with their partners, and finally they will share their models with the class. If students have not used this strategy before, it may be helpful to model the strategy with student volunteers. Students should discuss the different states of matter they modeled in this investigation and how their models explain the behavior of each state of matter.
2. Include some discussion about the different motions of the particles in the three states of matter. Refer to the paragraph in the Activity Activator section for basic details.
3. If time allows, ask students if they can demonstrate or model the motions of each state of matter. For example, students could link arms and line up in tightly packed clusters to model a solid. Encourage creativity and allow students to think of ways to model the other states with movement.
4. In order to apply and extend the concepts in this activity, bring out a deflated balloon and blow it up in front of students. After tying it, ask students what, if any, matter is inside the balloon.
5. Ask students to describe the positions and motions of the particles within the balloon. *(The particles of air are moving freely around inside the balloon and those near the inner surface are bouncing off and pushing against that surface, causing it to bulge out. Since the gas particles can push in all directions, and the balloon began as a small sphere, the final shape of the balloon ends up being spherical.)* Ask students what effect air particles would have on solid shapes such as leaves or fan blades. Discuss how moving air particles—as well as particles of solids (sand) and liquid (water)—can exert a pushing force on such objects.

Analysis and Conclusions: Think About the Activity

At the end of the investigation, instruct students to summarize their findings and their thinking by answering the analysis and conclusion questions.

Sample student responses shown.

Describe the arrangement of particles in the different states of matter you modeled in this investigation. *Answers may vary. In this investigation, we created models of solids, liquids, and gases. The particles in solids are tightly packed and have a regular pattern. Particles in liquids are close together but not well organized. They are more randomly arranged. Finally, particles in gases are quite far apart and not organized at all.*

What is matter composed of? *Answers may vary. Matter is made up of particles that are too small to see with the naked eye.*

Give examples of solids, liquids, and gases that you use every day. *Answers may vary. Solids: desk, pencil, door, car; Liquids: water, juice, rain; Gases: oxygen, carbon dioxide, water vapor*

What does the arrangement of particles in solids, liquids, and gases tell us about how materials in each state will behave? *Answers may vary. Particles in solids are tightly packed and organized. The particles are packed together so the object is hard. Particles in liquids are close together but move around, like how water flows freely. This explains how liquid is able to fill its container. Particles in gases are not close together and move around quickly. That is why we cannot see some gases with the naked eye. Gases will not fill an open container and will instead move freely. Gases in a closed container, like a balloon, will expand to fill the container, exerting a force or pressure on the walls of the container.*

Digital Extension Activity 16

Analyze Like a Scientist

10 min

Particles Always in Motion

Use this online extension activity to extend student exploration.

Quick Code: egst5056

Student Pages 140–141

Video Lesson 6

Quick Code: egst5054

Lesson 6

DIGITAL

Quick Code: egst5057

Student Pages 142–144

Student Page 143

Activity 17
Record Evidence Like a Scientist

25 min

States of Water

Instructional Purpose

In this activity, students return to the questions posed at the beginning of the concept and reconsider what they know now. Students construct a scientific explanation about the Investigative Phenomenon States of Water and the Can You Explain? question.

Scientific Context

The process of writing a scientific explanation using evidence to support a claim is a key step in students constructing scientific knowledge that they can then use and apply.

Life Skills **Endurance**

Strategy

Display the Investigative Phenomenon States of Water and the Can You Explain? question. Ask students to discuss and share with the class or a partner their explanation for the Investigative Phenomenon States of Water.

Students should discuss the various explorations of the states of matter that they engaged in throughout the concept. Students should reflect upon Hands-On Investigations and new information gained during Matter in the World around Us.

Sample student responses shown.

How can you describe States of Water now? Answers may vary. Students should reference particle movement, how closely the particles are packed together, and so on.

How is your explanation different from before? Answers may vary.

After allowing students to discuss,

ASK *How can this explanation help you answer the Can You Explain? question?*

Can You Explain?

What are the different forms of matter that can be found in the world around us?

As students would have already reviewed sample scientific explanations in earlier units, they should be familiar with the process of using evidence to support a claim. You may want to review the following:

A **claim** is a one-sentence answer to the question you investigated. It answers, What can you conclude? It should not start with *yes* or *no*.

Sample student responses shown.

My claim: *Answers may vary. The different forms of matter are solids, liquids, and gases.*

Evidence must be:

- Sufficient—Use enough evidence to support the claim.
- Appropriate—Use data that support your claim. Leave out information that does not support the claim.

At this level, students should be able to construct a scientific explanation that includes reasoning as part of the explanation.

Reasoning ties together the claim and the evidence, and:

- Shows how or why the data count as evidence to support the claim.
- Provides the justification for why this evidence is important to this claim.
- Includes one or more scientific principles that are important to the claim and evidence.

Student Page 144

Sample student responses shown.

Evidence: *Answers may vary. We saw evidence of this as we looked at and categorized different types of solids, liquids and gases in the activity Observing Matter. We learned that matter is made up of very small particles and that the particles behave differently depending on the state of matter.*

After providing scaffolding to students, allow them time to construct a full scientific explanation. Students can write, draw, or orally describe their claim, evidence, and scientific explanation that includes reasoning.

If time allows, invite students to share their claim, evidence, and scientific explanation with reasoning. Student answers in all sections will vary. Sample student answers are provided as a benchmark for possible responses.

Sample student responses shown.

Scientific explanation with reasoning: *Answers may vary. The three states of water that exist in the world around us are called solids (ice), liquids (water), and gases (steam). Each of these forms of water behaves in a unique way because of the nature of the particles that make up the material. These particles, or very small pieces of matter, change arrangement and movement depending on the state of matter of an object. In solids, they are tightly packed, neatly arranged, and move slowly. In liquids, they have more space to move around. This is why liquids can be poured and take the shape of any container they are placed into. The particles in a liquid move more quickly than in a solid. Gases are made up of particles that are very spread out. This is why gases can fill any container they are put in and have no fixed shape. The arrangement and movement of these particles can change as the state of matter changes. For example, as ice becomes water or water is turned into water vapor, the arrangement of particles changes.*

STEM in Action

DIGITAL

Quick Code: egst5059

Student Pages 145–146

Activity 18

Analyze Like a Scientist

20 min

Careers and States of Matter

Instructional Purpose

In this activity, students consider a career that involves the states of matter—a chef.

Scientific Context

Much of cooking and baking involves science. One way we use science in cooking is by using heat or cooling to produce edible goods from ingredients.

Life Skills **Creativity**

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning. Use the video and text provided to generate discussion about the work chefs do, how they can be scientists, and how they use water in three states.

After directing students to read the text and watch the video, lead them in a discussion about what goes into planning a meal. Encourage students to think of the preparation, cooking, and serving of food. Ask students to consider how both the chef and the guests eating the meal should handle foods prepared with and served at different temperatures. Allow students time to brainstorm before describing their "Taste the States of Matter" meal.

Student Page 146

Taste the States of Matter

Sample student responses shown.

Imagine that you are a chef, and you want to impress your guests with a special theme dinner called "Taste the States of Matter." You need to plan a creative meal that includes various flavors and illustrates the three main states of matter. What would you prepare for your guests? How would you plan the meal? Are there any safety considerations you or your guests would have to take? Answers may vary. Students' meals should include solids, liquids, and gases. (Gases may be in the form of aromas or smells.) Students should include the plans to both prepare and cook the food. Students should include any safety precautions needed to handle hot or cold temperatures.

ENTREPRENEURSHIP

Chefs in restaurants or even home chefs are often some of the most creative entrepreneurs. Chefs manage a variety of resources, from ingredients to cooking tools to personnel (if they own a restaurant or manage a staff). Encourage students to think of ways chefs must display leadership and set goals to stay motivated.

Digital Extension Activity 19
Evaluate Like a Scientist

15 min

Review: Matter in the World around Us

Use this online extension activity to extend student exploration.

Quick Code:
egst5060

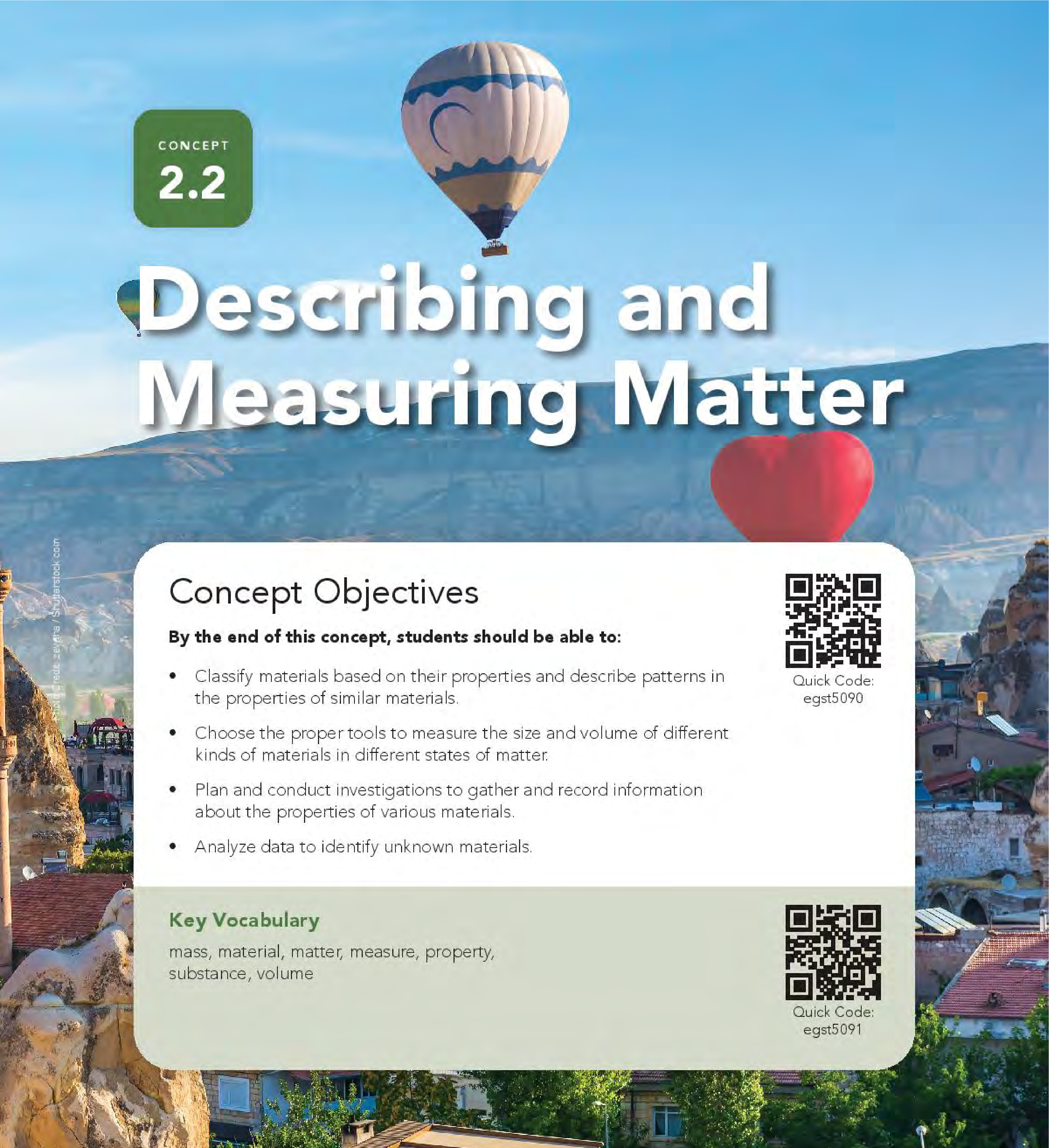


Photo Credit: zevana / Shutterstock.com

CONCEPT

2.2

Describing and Measuring Matter

Concept Objectives

By the end of this concept, *students* should be able to:

- Classify materials based on their properties and describe patterns in the properties of similar materials.
- Choose the proper tools to measure the size and volume of different kinds of materials in different states of matter.
- Plan and conduct investigations to gather and record information about the properties of various materials.
- Analyze data to identify unknown materials.

Quick Code:
egst5090

Key Vocabulary

mass, material, matter, measure, property, substance, volume

Quick Code:
egst5091

Concept Pacing

Recommended Pathway

In order to meet the expectations of the standards, students must complete each activity within the recommended pathway.

Location	Days	Model Lesson	Time
Wonder	Lesson 1	Activity 1	5 min
		Activity 2	20 min
		Activity 3	20 min
Learn	Lesson 2	**Activity 4**	25 min
		Activity 6	20 min
	Lesson 3	**Activity 9**	35 min
		Activity 10	10 min
	Lesson 4	Activity 11	25 min
		Activity 12	20 min
Share	Lesson 5	Activity 13	20 min
		Activity 14	25 min

Bold activities are Hands-On Investigations.
A full list of materials required, along with any additional preparation, can be found online.

Quick Code:
egst5092

Content Background

Properties of Matter

We interact with matter in the form of materials (water, air, fabrics) and objects (marbles, organisms, buildings). Typically, we characterize these materials and objects by describing their properties. Some common properties include size, shape, color, texture, temperature, and hardness. People commonly use relative terms to describe objects (large, small, cold, hot, rough). Throughout this concept, students will be asked to gather and record data regarding the properties of items in various states. The manner in which students make careful observations, consider differences in properties and reactions, and analyze their data will be critical to the identification of items that appear similar in many ways.

Measuring Matter

Scientists use exact measurements and clearly defined categories (such as temperature and a hardness scale) to identify and investigate materials. It is often important to quantify the amount of matter in a material or an object, and typically we do this by measuring the mass, the volume, or both. In the previous concept, students learned about the basic characteristics of matter. The type of measurement that is appropriate depends on the state of matter of the material. Understanding the defining qualities of each of the states is a precursor to understanding how materials can be measured. In this concept, students will learn to decide which tools and units of measurement are appropriate choices for measuring either a solid, liquid, or gas.

Students learn that the same type of matter can have different properties, even though its mass remains constant unless we add or take away matter. Volume, however, may change as a type of matter goes through a change of state. At this age, we do not typically explain conservation of mass at the atomic level, but some students may be able to understand that the mass remains the same because the number of molecules does not change when the material changes states.

Video Lesson 1

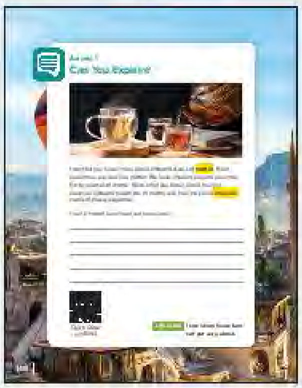
Quick Code: egst5093

Lesson 1

DIGITAL

Quick Code: egst5094

Student Page 148



Activity 1
Can You Explain?

5 min

How is matter described and measured?

Instructional Purpose

In this introductory activity, students explain what they already know about describing and measuring matter in order to activate prior knowledge.

Scientific Context

All things are made of matter and have different characteristics. Understanding the properties of matter will help students handle and use matter properly.

Life Skills **Endurance**

Strategy

Encourage students to explain what they know about the properties of various materials. Challenge students to think about how they can describe and measure material properties. Ask students to look at the image and share what they notice with a partner. Some students might recognize that there is a solid (cinnamon stick, tea bag), liquid (hot tea), and gas (steam) pictured in the image.

ASK *What do you know about the properties of materials?*
Answers may vary. Students may describe the defining characteristics of each state of matter. (For example, liquids can be poured.) Students may also begin to describe physical attributes of various materials.

Display the Can You Explain? question so that all students can see it. Students may have some initial ideas about how to answer the question. Students should be able to construct a scientific explanation by the end of the concept. The explanation will include evidence from the concept activities. Keep in mind that students' answers may not be fully formed at this point in the concept.

Sample student responses shown.

How is matter described and measured? Answers may vary. Matter can be described by color, shape, texture, or size. You can also describe matter based on its state. Matter can be measured using a tool like a balance, ruler, or thermometer.

Investigative Phenomenon

Activity 2

Ask Questions Like a Scientist

20 min

A Roof for Every Climate

Instructional Purpose

The Investigative Phenomenon is designed to ignite student curiosity about events in the world around them. In this activity, students examine the properties of three different roofing materials and develop testable and non-testable questions about the properties of matter.

Scientific Context

By considering the properties of different materials, students recognize why some materials are chosen for a project and others are not. A roof provides protection from the elements, keeps your home warm, and protects your home's structure. Different climates require different roofing materials.

Strategy

Engage students by asking them to think of the different types of roofs they see on buildings in their neighborhood.

ASK *What kinds of material do people use to make roofs on buildings and homes?*
Answers may vary. Roofs may be made of ceramic tiles, asphalt shingles, wood, metal, grass, and mud.

Allow students to share what they know about roofing materials from roofs that they have seen on their homes, the school, or other places in the neighborhood. Elicit a discussion about the type of material the roof was made of and whether the students think that the type of material plays a role in how effective the roof is. For example, if the school had a cloth roof and there was a heavy rainstorm, everyone might get wet.

This discussion will allow students to begin considering some of the properties of different materials. After the discussion, direct students to independently review the three roof images.

DIGITAL

Quick Code: egst5095

Student Pages 149–150

Lesson 1, *continued*

ASK

- *What do you notice about the different roofs in the images?*
  Answers may vary. Some are flat, others are slanted, one is made of leaves and sticks.
- *Why do you think we might pick different materials or shapes for different roofs?*
  Answers may vary. Some places might get a lot of rain or snow, so would need a different shape or material for their roofs.
- *What are each of these roofs doing in the images?*
  Answers may vary. The roofs are protecting the house from rain, animals, dust, dirt, or other things getting inside.
- *Do you think rain comes through these roofs? Why or why not?*
  Answers may vary. It looks like the first two roofs are very solid. Even the third image seems like the roofing materials are tightly packed.
- *Do falling branches come through the roof? Why or why not?*
  Answers may vary. It would depend on how large of a branch and how strong the roofing material is.
- *What are good properties or characteristics for roofs to have?*
  Answers may vary. It should keep out the rain, be sturdy, not blow off in the wind or let in rainwater.

Guide students to consider their own questions about properties of roofing materials. As you complete the activities in Learn, students should look for evidence to answer their questions.

Student Page 150

Sample student responses shown.

I wonder . . .	*Answers may vary. Should roofs reflect or absorb heat energy from the sun?*
I wonder . . .	*Answers may vary. Do some roofing materials last longer than others?*
I wonder . . .	*Answers may vary. Where do people find the materials for their roofs?*

Teacher Reflection

- Did this activity engage students?
- Did this activity allow students to generate their own questions?
- Would I introduce the concept of properties of materials differently next year?

Activity 3
Evaluate Like a Scientist

20 min

What Do You Already Know About Describing and Measuring Matter?

Instructional Purpose
Students continue to reflect on what they already know about describing and measuring matter.

Scientific Context
Everything you can see and touch is made of matter. Matter can be easily described and measured using physical and chemical properties. Physical properties of matter can be observed without changing the identity of the matter. Chemical properties describe a substance based on its ability to change into a new substance that has different properties.

Describing Matter

Strategy
The item Describing Matter provides a formative assessment of students' ability to qualitatively describe matter. Students should already have a basic understanding of the three states of matter and how solids, liquids, and gases differ from one another.

Sample student responses shown.

What are some ways you can describe matter? Answers may vary. Matter can be described by its color, shape, odor, texture, and size.

Measuring Matter

Strategy
The item Measuring Matter provides a formative assessment of students' existing knowledge of tools used to measure matter.

After the assessment, use student input to create a class list of additional tools and instruments used to measure properties of matter. As students mention specific items, ask what properties of materials each item would measure. For example, a balance or scale would be used to measure the weight of an object and a tape measure would be used to measure the dimensions of a room. Tell students they will be using some of these tools and instruments in this lesson to help them identify materials based on their properties.

DIGITAL

Quick Code: egst5096

Student Pages 151–152

Lesson 1, *continued*

Sample student responses shown.

Use the word bank to label each tool with the property that it measures.

Measuring Cup: *Volume* Tape Measure: *Length* Balance: *Weight*

Discuss with Your Class

Strategy

The item Discuss with Your Class provides a formative assessment of students' experience with scientific tools to measure properties of matter.

After the assessment, lead a class discussion of what students already know about ways to describe matter. This discussion, along with the activities in this lesson, helps students understand that there are a variety of ways that matter can be described and measured.

Sample student responses shown.

Student Page 152

What are some tools that you have used or seen before to measure properties of matter? Record any tool you can think of and what property it measures. Answers may vary.

Tool: *Ruler, thermometer* Property: *Length, temperature*

Why is it useful to measure different properties? Answers may vary. Every material has a variety of properties. Depending on the use of the material, you may need to measure more than one property to determine if the the material is the right one to use.

Teacher Reflection

- What do my students already know about describing and measuring materials by their properties?
- What do my students not understand about describing and measuring materials by their properties at this point?
- What misconceptions do my students have at this point in the course?
- Are any of my students ready for extension at this point in the lesson?

Activity 4
Investigate Like a Scientist

25 min

Hands-On Investigation: The Case of the Kitchen Mystery

Instructional Purpose

This activity encourages students to use their senses to describe the state of matter, color, size, shape, texture, and odor different substances may have. Investigating a variety of substances that look alike by identifying their observable properties develops student understanding of physical properties.

Scientific Context

Physical changes happen when some properties change (such as shape), but the material itself is the same before and after the change. The change can be undone. Allowing students to observe physical properties of similar substances will highlight subtle differences in properties such as texture, odor, and so on.

Teacher Preparation

Before class, mix equal parts of baking soda and salt to create the mystery mixture. If any of the white substances used in this investigation are not available, consider using alternatives such as plaster of paris, powdered sugar, powdered milk, baby powder, or cornstarch.

Activity Activator: Make a Prediction

In this activity, students will investigate a variety of substances that look alike by identifying their observable, physical properties. Five of the substances are known. The mystery mixture is a combination of two of the known substances.

As a class, define properties as a way to describe matter. Hold up a book and ask students to describe the book by its properties. Encourage students to use their senses to describe the book's state of matter, color, size, shape, texture, and odor. You may want to pass the book around to allow students to smell and feel it.

Tell students that you need their help to solve a mystery. Your friend Ahmad works in a restaurant and makes the most amazing cookies. However, a new worker was cleaning out the canisters of flour, salt, sugar, baking soda, and baking powder. When putting the materials back in the canisters, two of the substances got mixed together. Ahmad needs to know which powders are in the mixture so he can still use it to make his cookies. Ahmad asked if students could carefully observe each powder and help him identify the differences. The clues that students gather from what they know can help Ahmad figure out the identity of the mystery mixture.

DIGITAL

Quick Code: egst5098

Student Pages 153–156

Materials List

(per group)

- Plastic bag with 20 g sugar, labeled
- Plastic bag with 20 g salt, labeled
- Plastic bag with 20 g baking powder, labeled
- Plastic bag with 20 g baking soda, labeled
- Plastic bag with 20 g flour, labeled
- Plastic bag with 20 g of mystery mixture (10 g baking soda and 10 g salt mixed together), labeled
- Spoons
- Hand lenses
- Piece of black construction paper, 25 cm x 10 cm
- White crayon or colored pencil
- Microscope (optional)

Lesson 2, *continued*

Before students begin the investigation, remind them of the safety rules, especially the rule against tasting the substances. Direct students to record their predictions in Make a Prediction.

Sample student responses shown.

Predict which sense will be the most helpful to solve this mystery—sight, smell, or touch—and explain why. Answers may vary. Sight will be the most helpful because you can look at the different powders and tell the difference between them. Touch will be most helpful because for example, flour and sugar have very different textures.

Safety

- Follow all lab safety guidelines.
- Follow proper disposal and cleaning procedures after the lab.
- Clean up any spills of water immediately.
- Never taste unknown substances.
- Use only the amount directed. Do NOT use more than directed.

Activity Procedure: What Will You Do?

1. Direct groups not to touch any of the materials until directions have been given. Hand out a tray to each group with the materials. Each bag should be labeled so that groups know exactly which substance is in each.
2. Direct groups to draw six circles in a row on the black paper and label each circle with the name of each substance. If possible, hold up an example for the class to see.
3. Ask students to observe the substances and complete the second column of their investigation chart, labeled "Color."
4. Instruct students to use a plastic spoon to place a small amount of each substance in the appropriate labeled circle on the black paper.
5. Direct students to feel the texture of each substance by pinching a small amount from the pile on the paper and rubbing it gently between two fingers. Point out the third column of their investigation chart, labeled "Texture." Tell students to pay close attention to how the grains feel because that is what they will need to record after feeling each substance. Circulate around the room to ensure that students are observing accurately and are not spilling any of the materials.
6. Instruct students to complete the next column of their investigation chart, labeled "Odor." Students should smell the substances by gently wafting the odor to them. Demonstrate this process by hovering near a substance. Use one hand to wave air across the pile of powder and toward your nose. Point out that the observer's nose should never be directly above the powder and that wafting ensures that no powder is inhaled while observing the odor.

7. Allow students time to observe the substances using a hand lens (or microscope if available) while making notes in the column labeled "Other Observations."
8. At the end of class, collect the materials from the students and dispose of the papers.
9. Direct students to return their trays to a central location.

Analysis and Conclusions: Think About the Activity

Direct students to reflect on their investigations and answer the questions.

Sample student responses shown.

How were all of the substances (sugar, salt, baking powder, baking soda, and flour) similar to one another in terms of their physical properties? How were they different? Answers may vary. The substances had similar color, but some felt like they were made up of large crystals while some had very fine particles.

How did the hand lens help your observations? Answers may vary. Using the hand lens, we could see small crystals.

If these substances were not labeled, could you tell them apart by just their physical properties? Answers may vary. It would be very hard to tell these substances apart without their labels.

Can you predict what is in the mystery mixture? Answers may vary.

Student Page 156

Digital Extension Activity 5

Investigate Like a Scientist

20 min

Hands-On Investigation: Shape and Volume of Liquids and Solids

Quick Code: egst5099

Use this online extension activity to extend student exploration.

DIGITAL

Quick Code:
egst5101

Student Pages 157–158

Activity 6
Analyze Like a Scientist

20 min

Properties of Matter

Instructional Purpose

As a follow-up to the Hands-On Investigation, students read about properties that they did not measure in the previous activity. This reading passage allows students to gather more evidence that they can use to support their response to the Can You Explain? question.

Scientific Context

Understanding the properties of matter can help you choose the right materials. For example, if you are going on a canoe trip down the Nile and want to take along some cold drinks, a Styrofoam cooler would be a good choice of material. Styrofoam is not dissolved by water and is a good insulator. However, if you wanted to store some acetone for a science project, a Styrofoam container would not be a good choice. Acetone easily dissolves Styrofoam, meaning it would melt through.

Strategy

Students should read the text section that describes some of the many properties of matter that can be observed and measured.

As students read, engage them in the instructional strategy Placemat, by placing them in small groups of four. Provide each group with a sheet of chart paper. Divide the chart paper into four equal boxes with space for one more box in the center. Students should each take notes in one corner of the chart paper to gather evidence that they can use to support their response to the Can You Explain? question. After students take individual notes in their corner box, allow students time to share within their groups. Students should then summarize their collective notes into three or four main points and write them in the center of their placemat.

Sample student responses shown.

Once you have completed the reading, circle the properties of matter you can observe and measure. Students should circle the following terms: color, shape, odor, texture, ability to burn, ability to rust.

Digital Extension Activity 7
Evaluate Like a Scientist

15 min

Observable Properties

Use this online extension activity to extend student exploration.

Quick Code: egst5102

Digital Extension Activity 8
Observe Like a Scientist

15 min

Does Gas Have Mass?

Use this online extension activity to extend student exploration.

Quick Code: egst5103

Video Lesson 3

Quick Code: egst5100

Lesson 3

DIGITAL

Quick Code: egst5105

Student Pages 159–162

Materials List
(per group)

- Bar magnets
- Balance
- Water
- Metric ruler
- Beaker, glass, 150 mL
- Paper clips
- Beads
- Aluminum foil
- Wooden blocks

Activity 9
Investigate Like a Scientist

35 min

Hands-On Investigation: Measuring Properties

Instructional Purpose

In this Hands-On Investigation, students plan and choose their own method to measure the physical properties of matter. Encourage students to cooperate during their investigation so that group tasks are evenly distributed. Groups should also work together to plan how they will present their findings to the class.

Scientific Context

Objects are made up of very tiny molecules. Objects with tightly packed molecules have greater density than those where the molecules are spread out. The density of an object determines whether it will float or sink in another substance. An object will float if it is less dense than the liquid it is placed in. An object will sink if it has a greater density than the liquid it is placed in. Students commonly believe that heavier objects will sink and lighter objects will float, regardless of their size, shape, or material used to make them.

Activity Activator: Make a Prediction

In this activity, students select equipment and plan an investigation about matter. Student groups will measure the physical properties of matter, including mass and the ability to sink or float. Teams will organize their data into graphic organizers.

Place students into small groups of two or three and provide each group with the activity materials. If any of the tools are unfamiliar to students, demonstrate the use of these tools. Ask groups to discuss how they will investigate the properties of the materials using the tools. Ask students to create a list of tools they will need to investigate each property. Instruct students to list the tools in their science journals or on a separate piece of paper.

Sample student responses shown.

If you cut an object in half, how does the mass of one of the pieces compare to the mass of the original object? Answers may vary. The mass of one of the pieces should be half of the mass of the original object.

What do you think makes an object float? Answers may vary. An object that is light for its size is more likely to float.

Activity Procedure: What Will You Do?

1. Once students have the materials, allow groups to review the properties listed in the data table. Ask groups to decide which properties to study (they do not have to study all those that are listed in the data table). Instruct students to come up with an additional property to study and record that in the last row of the data table. Make sure that students select properties they can observe, such as shininess, length, shape, and so on. Students should not assume properties. For example, some students may have heard of electric conductivity and may assume that the paper clip and aluminum can conduct electricity. However, this is not a property that students will be able to observe.

2. Ask students to measure or test as many objects as they can using the available tools. If time is limited, you may wish to assign each student one object so that he or she has an opportunity to perform the different types of measurement. All students in the group should record the data for each object. As you check in on each group, make sure that students are using the tools correctly and that they know which properties they are measuring. Students should be able to explain that they use the balance to measure mass, the ruler to measure length (be sure to review if students need help), and the magnet to test for magnetic attraction. Students should also explain that the beaker of water could be used to find if an object sinks or floats.

3. Encourage students to check their measurements carefully. For instance, would students expect the paper clip to have more mass than the wooden block, based on their other observations? Students may need to use more than one object to equal one gram when measuring mass (For example, students may need three beads to equal one gram).

4. As you circulate among the groups, challenge students to think beyond the basic properties that they are measuring. For example, ask students to consider how changing one property might affect another property.

   ASK *Will changing the shape of the foil change the mass? What would happen if you cut the foil in half and measured the mass of one half?* *Changing the shape of the foil will not change the mass. If you cut the foil in half and measure the mass of that half, the mass would be half the mass of the original piece of foil.*

5. Remind students to use the tools to find answers to the questions they answered in Make a Prediction.

Safety

- Follow all lab safety guidelines.
- Follow proper disposal and cleaning procedures after the lab.
- Clean up any spills immediately.
- Be careful using glass objects, such as beakers.
- Wear proper safety attire, including safety goggles.
- Tie back long hair.
- Do not eat or drink anything in the lab.

Lesson 3, *continued*

6. Give students the opportunity to analyze their information and organize objects based on their properties.
7. If time allows, ask students to construct a graphic organizer or simple poster to share their findings. Have students make as many different groups as possible and record the objects in each group. For example, students could organize objects by mass, size, shininess, and attraction to magnets.
8. Come together as a class to compare results. Have each group share one of their object classifications with the class. Discuss how being able to classify the objects with that classification might be useful. For example, plastic does not have much mass for its size. This might help a designer determine that plastic should be used in backpack construction because it would make the backpack less heavy.

Sample student responses shown.

Which properties did you study? Answers may vary. I studied color, texture, mass, whether the object was attracted to the magnet, and whether an object floated or sank in water.

Analysis and Conclusions: Think About the Activity

Direct students to reflect on their investigations and answer the questions.

Sample student responses shown.

Student Page 162

What tools did you select for this investigation? Answers may vary. I used a beaker, balance, magnet, aluminum foil, and paper clip.

How does changing the size of an object change its physical properties? Answers may vary. Most properties will not change. The mass will always be different from the original mass. Sometimes, an object will not float after you cut it into two halves, such as a ping pong ball.

Describe one of your groups. What objects did you include in that group? Why did you group those objects together? Answers may vary. I grouped the paper clip and aluminum foil ball together because they are both shiny.

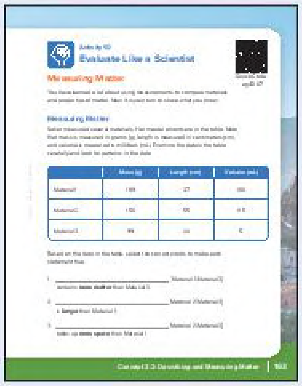
Activity 10
Evaluate Like a Scientist

10 min

DIGITAL

Quick Code:
egst5107

Student Page 163



Measuring Matter

Instructional Purpose

This formative assessment allows students to demonstrate how to identify patterns in data and answer scientific questions about the properties of matter.

Scientific Context

In science, finding patterns is extremely important. A pattern is when data repeats in a predictable way. Patterns allow scientists to make predictions with greater certainty. Problems are easier to solve when they share patterns, because the same problem-solving solution can be used wherever the pattern exists.

Measuring Matter

Strategy

In the item Measuring Matter, students analyze sets of data to determine patterns that suggest relationships between different properties of matter.

Students should consider how they can combine their understanding of measurable properties of matter and math concepts to address scientific questions about the properties of matter.

Allow students to work in pairs to examine the table and use the data to complete the item.

MISCONCEPTION

Students may believe that matter that takes up more space has more mass. Students may think that larger objects must have more mass than smaller objects. However, some objects have more matter packed into a smaller amount of space than other objects. A good example of this is a baseball and an empty milk carton. The milk carton is larger, but the baseball has more mass.

Lesson 3, *continued*

Sample student responses shown.

Based on the data in the table, select the correct words to make each statement true.

Material 1 contains more matter than Material 2.

Material 2 is longer than Material 1.

Material 2 takes up more space than Material 1.

Teacher Reflection

- How knowledgeable are my students about using measurements to compare materials and properties of matter?
- Are there additional techniques I could use to help my students identify and use properties of materials?

Video Lesson 4

Quick Code:
egst5104

Activity 11
Analyze Like a Scientist

25 min

Useful Properties of Matter

Instructional Purpose

In this activity, students read a text and watch a video to obtain information to make predictions about how various types of matter can be used in specific applications. Understanding that specific properties determine how materials may be used will support students as they investigate different materials in their unit projects.

Scientific Context

Materials are evaluated for their properties and the job they are expected to do. For example, metal conducts heat, which means that it might burn your hand if it is used as the handle of a pot. Plastic is a better choice for a pot handle because it does not conduct heat as well as metal.

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

Instruct students to take an inventory of the different forms of matter in the classroom. Consider allowing students to also think about matter in their homes and add these examples to their lists. As a class, discuss how the specific properties and their uses are related.

Students should read the text describing how some properties of materials can be advantageous for specific purposes. If available, provide examples of a helium balloon, copper metal, and glass for students to examine.

Allow students to think of one additional application for each of the examples of matter discussed in the text. For example, students may think that copper could be used for electricity in their house, due to its ability to conduct electricity. Students may have difficulty identifying additional applications for helium. Helium is often used in industrial applications, with which students may not be familiar. If students cannot think of an example beyond balloons or a blimp, provide them with examples such as nuclear medicine, providing a protective area around types of welding, and a mix of helium and oxygen that is used by underwater divers.

Show students the video. Ask students to look for the properties of the materials and how the properties effect their use.

DIGITAL

Quick Code:
egst5108

Student Pages 164–165

Lesson 4, *continued*

Once students have read the text and watched the video, allow time for students to complete the student response item. If time allows, call on students to share their answers.

Student Page 165

Sample student responses shown.

Helium: *Answers may vary, such as a blimp that hovers over a stadium during a sports game.*

Copper: *Answers may vary, such as a cooking pot.*

Glass: *Answers may vary, such as a window, eyeglasses, a jar.*

What is another material for which there are specific applications? Answers may vary.

Activity 12
Evaluate Like a Scientist

20 min

Uses of Matter

Instructional Purpose

This formative assessment serves as an opportunity to observe students' ability to make the connection between structure and function.

Scientific Context

Different materials have different properties. The properties of a material determine its suitability for a particular use. Understanding how materials behave will help students understand why objects are made of specific materials.

Strategy

In the item Uses of Matter, students will apply their understanding of how the structure of matter determines its function. Instruct students to work in pairs to identify properties that make each material useful for the stated purpose.

If students are unfamiliar with the materials steel, glass, and rubber, show the class images of each one and discuss where they might have seen these before in their everyday lives. For example, steel is used in many bridges, glass is used to make windows, and rubber is found at the bottom of athletic shoes or in many sports balls, such as basketballs.

Sample student responses shown.

Steel: *hard, strong*

Glass: *transparent, smooth*

Rubber: *waterproof, flexible*

Teacher Reflection

- Can my students make the connection between structure and function? In this case, can they make the connection between a given set of properties of a material and a useful function?
- Are my students able to recognize a variety of properties of materials, such as melting temperature, density, and odor, as well as more common properties, such as size, weight, and color?
- Can my students distinguish between quantitative properties of a material (weight of 25 grams) and qualitative properties (soft)?

DIGITAL

Quick Code:
egst5110

Student Page 166

Video Lesson 5

Quick Code:
egst5106

Lesson 5

DIGITAL

Quick Code:
egst5111

Student Pages 167–169

Activity 13

Record Evidence Like a Scientist

20 min

A Roof for Every Climate

Instructional Purpose

In this activity, students return to the questions posed at the beginning of the concept and reconsider what they know now. Students construct a scientific explanation about the Investigative Phenomenon A Roof for Every Climate and the Can You Explain? question.

Scientific Context

The process of writing a scientific explanation using evidence to support a claim is a key step in students constructing scientific knowledge that they can then use and apply.

Life Skills **Creativity**

Strategy

Display the Investigative Phenomenon A Roof for Every Climate and the Can You Explain? question. Ask students to discuss and share with the class or a partner their explanation for the Investigative Phenomenon and how the properties of the various roofs allow them to protect the buildings that they cover.

Sample student responses shown.

Student Page 168

How can you describe A Roof for Every Climate now? Answers may vary. Students should mention different properties of materials including hardness, texture, color, and other material properties.

How is your explanation different from before? Answers may vary.

After allowing students to discuss,

ASK *How can this explanation help you answer the Can You Explain? question?*

Can You Explain?

How is matter described and measured?

As students would have already reviewed sample scientific explanations in earlier units, they should be familiar with the process of using evidence to support a claim. You may want to review the following:

A **claim** is a one-sentence answer to the question you investigated. It answers, What can you conclude? It should not start with *yes* or *no*.

Sample student responses shown.

My claim: *Matter can be described and measured by making observations and using tools, instruments, and equipment.*

Evidence must be:

- Sufficient—Use enough evidence to support the claim.
- Appropriate—Use data that support your claim. Leave out information that doesn't support the claim.

At this level, students should be able to construct a scientific explanation that includes reasoning as part of the explanation.

Reasoning ties together the claim and the evidence, and:

- Shows how or why the data count as evidence to support the claim.
- Provides the justification for why this evidence is important to this claim.
- Includes one or more scientific principles that are important to the claim and evidence.

Sample student responses shown.

Evidence: *We learned from the activities that matter has both physical and chemical properties that can be described and measured. Color, shape, odor, mass, volume, and texture are examples of physical properties. In our Hands-On Investigations, we used balances to measure the physical property of mass. We also tested the properties of magnetism and whether a substance will sink or float in water. Chemical properties include the ability of a substance to burn or rust.*

Student Page 169

Lesson 5, *continued*

After providing scaffolding to the students, allow students time to construct a full scientific explanation. They can write, draw, or orally describe their claim, evidence, and scientific explanation that includes reasoning.

If time allows, invite students to share their claim, evidence, and scientific explanation with reasoning. Student answers in all sections will vary. Sample student answers are provided as a benchmark for possible responses.

Sample student responses shown.

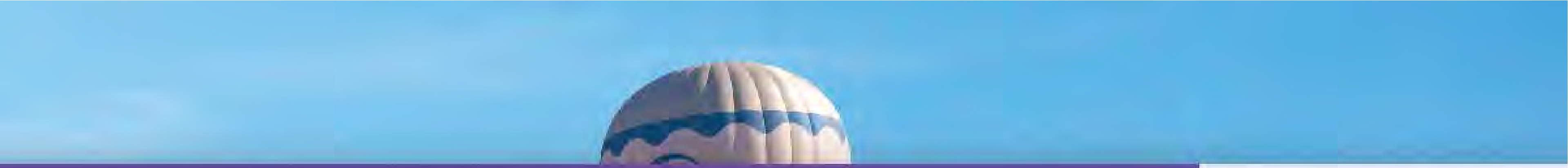
Scientific explanation with reasoning: *We can start by describing matter using our senses. We can usually easily determine color, texture, odor/smell, or shape using observations. For other properties, using tools to make measurements is required. For example, you can use a balance to determine mass, a labeled container to measure volume and a thermometer to measure temperature. Some properties require experimentation to determine, like the ability to sink or float. Once we have data on the properties of a substance, we can then use those properties to identify and classify the substance.*

DIFFERENTIATION

Advanced Learners
For students that show a more advanced understanding of how to describe and measure matter, challenge them to use units in their scientific explanation. For example, ask students to include the standard unit of measure for the properties of length, mass, volume, and temperature.

Teacher Reflection

- How has my students' construction of scientific explanations improved from earlier in the course?
- How did I provide scaffolding for students to construct their scientific explanations?
- How do I know my students are ready to apply the core content knowledge to another context?



STEM in Action

Activity 14
Analyze Like a Scientist

25 min

Careers and Measuring Matter

Instructional Purpose
Students have explored ways to describe and measure matter. In this activity, students learn how different careers rely on accurate measurements of matter.

Scientific Context
By measuring objects, we can better understand the world around us. Time, size, distance, speed, direction, mass, volume, temperature, pressure, force, sound, light, and energy are some of the physical properties we have developed accurate systems to measure.

Strategy
Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

After reading the text and watching the video about cartography, students should complete the assessment item.

Sample student responses shown.

What are three properties that are important to measure in the careers described in this activity? Why do bakers, scientists and cartographers need to make precise measurements? Answers may vary. Bakers measure volume and mass, scientists may measure length and cartographers may also measure hardness of materials. It is important to make precise measurements for many reasons. In baking, using the wrong amounts of an ingredient may ruin a cake. In science, it is important to track changes when doing experiments. In cartography, accurate measurements are important for making maps that people can follow.

DIGITAL

Quick Code: egst5113

Student Pages 170–172

Student Page 172

Lesson 5, *continued*

ENTREPRENEURSHIP

Measuring and tracking data is an important part of running a successful business, no matter what field or genre. Bakers use precise measurements to replicate results so that people who sample their goods will enjoy the same good tastes over and over. Scientists use measurements to determine outcomes from experimentation. Finally, cartographers must use precise measurements to avoid making inaccurate maps. Students should see the attention to detail as an example of the entrepreneurial skills of self-management and self-awareness.

Digital Extension Activity 15
Evaluate Like a Scientist

20 min

Review: Describing and Measuring Matter

This extension activity can be found online. Review activities allow students to summarize learning and apply information from the concept to the unit topic, or theme.

Quick Code: egst5114

Photo Credit: K.-U. Häßler / Shutterstock.com

CONCEPT

2.3

Comparing Changes in Matter

Concept Objectives

By the end of this concept, students should be able to:

- Explain the relationship between changes in temperature, states of matter, and mass.
- Identify the causes of changes in the physical and chemical properties of matter.
- Investigate what happens when two or more substances are mixed.
- Classify mixtures and compounds based on what happens when they are combined.

Quick Code:
egst5144

Key Vocabulary

chemical change, chemical properties, compound, energy, friction, heat, light, melt, mixture, physical change, thermal energy, water vapor

Quick Code:
egst5145

Concept Pacing

Recommended Pathway

In order to meet the expectations of the standards, students must complete each activity within the recommended pathway.

Location	Days	Model Lesson	Time
Wonder	Lesson 1	Activity 1	5 min
		Activity 2	10 min
		Activity 3	20 min
Learn		Activity 4	10 min
	Lesson 2	**Activity 5**	30 min
		Activity 6	15 min
	Lesson 3	Activity 7	20 min
		Activity 8	10 min
		Activity 9	15 min
	Lesson 4	**Activity 10**	45 min
	Lesson 5	Activity 11	10 min
		Activity 12	15 min
		Activity 13	20 min
	Lesson 6	Activity 14	20 min
		Activity 15	25 min
Share	Lesson 7	Activity 16	15 min
		Activity 17	20 min
		Activity 18	10 min
Unit Project	Lesson 8	Unit Project	45 min

Bold activities are Hands-On Investigations.
A full list of materials required, along with any additional preparation, can be found online.

Quick Code:
egst5146

Content Background

Changes to Matter

At this point in the unit, students are well-versed in the defining characteristics of solids, liquids, and gases. Students have practiced describing and measuring materials in various states. Students also modeled the arrangement of particles in various states. Understanding why materials in different states behave as they do, based on particle movement, is critical to understanding all changes to matter. With this understanding established, students are now ready to explore more sophisticated changes. Temperature is the primary factor involved in all changing states of matter. In this concept, students will learn the difference between physical and chemical changes. Students will also learn about how different materials can be combined in mixtures and solutions.

Physical and Chemical Changes

Matter can be changed physically or chemically. While physical changes do not alter the chemical composition of a substance, chemical changes do. Physical changes modify at least one physical property of the substance—for example, size, shape, or state. Physical changes do not change any of the chemical properties of a substance. Water changing to ice is a physical change. Aluminum foil being crumpled and pressed into a small, hard lump is a physical change. Sugar dissolving into water is a physical change; the sugar is still sugar even though its molecules are suspended in water. Most physical changes can be reversed easily, such as by evaporating the water from the sugar solution. On the other hand, chemical changes, such as rusting or burning, result in substances with new chemical and physical properties. Iron combines with oxygen to form rust. Carbon in paper or wood combines with oxygen to release heat and turn to ash. Chemical changes are not easily reversed.

Mixtures versus Compounds

Mixtures are combinations of substances that are not chemically combined. Mixtures can occur in all states of matter, and sometimes involve combining materials in two different states. The components of a mixture can be separated by sorting, filtering, or evaporation. Solutions, such as sugar dissolved in water, are mixtures that are evenly mixed. While a mixture is made of two or more different substances that are not chemically joined, compounds are chemically combined substances, such as water. Mixtures can be separated by their physical properties, while compounds can only be separated chemically.

Video Lesson 1

Quick Code: egst5147

Lesson 1

DIGITAL

Quick Code: egst5148

Student Page 174

Activity 1

Can You Explain?

5 min

What happens to the mass of a substance when it is heated, cooled, or mixed with other substances?

Instructional Purpose

In this introductory activity, students communicate what they know about conservation of mass and the behavior of particles when there is a change in matter.

Scientific Context

The mass of a substance does not change when the substance is heated, cooled, or mixed with other substances.

Life Skills **Endurance**

Strategy

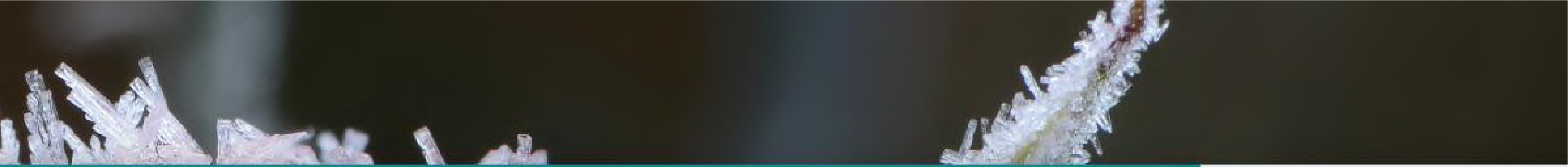
Encourage students to explain what they know about what happens at the particle level when thermal energy (heat) is added to or removed from a substance. Challenge students to think of real-world examples they have observed where substances have been cooled, heated, or mixed with other substances.

ASK *What happened during a time when you observed a change in matter? Answers may vary. Students may reference observing water change physical states, such as solid ice melting into water. They may also reference changes that are chemical, such as observing rusting or other examples.*

Display the Can You Explain? question so that all students can see it. Students may have some initial ideas about how to answer the question. Students should be able to construct a scientific explanation by the end of the concept. The explanation will include evidence from the concept activities. Keep in mind that students' answers may not be fully formed at this point in the concept.

Sample student responses shown.

What happens to the mass of a substance when it is heated, cooled, or mixed with other substances? Answers may vary. The mass of a substance does not change when heated or cooled. When we heat up an ice cube, it changes from a solid to a liquid.



Investigative Phenomenon

DIGITAL

Quick Code: egst5149

Student Pages 175–176

Activity 2
Ask Questions Like a Scientist

10 min

Melting Matter

Instructional Purpose

The Investigative Phenomenon is designed to ignite student curiosity about events in the world around them. In this activity, students make careful observations of ice cubes melting and water evaporating and generate questions that can be investigated about the causes of phase changes.

Scientific Context

Ice is solid, frozen water. As heat is added, the ice melts, turning from a solid into a liquid. Ice melts at different speeds on different surfaces. By understanding the factors that make ice melt, we can use more appropriate materials to help keep ice from melting too fast.

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

1. Place several ice cubes in a bowl or similar container so students can make observations about the phenomena of ice melting and then water evaporating. Consider using a hot plate or other source of heat to speed along the melting of the ice cubes. Alternatively, give each student an ice cube and a paper towel and let them place the ice cube on their desk to melt.
2. As the ice melts, solicit student observations. Encourage students to develop their own questions about their observations.
3. Direct students to watch the video Let's Investigate Melting Matter and read the text provided.
4. Pair students with a partner. Allow each student four minutes to discuss what happened with the juice boxes in the kitchen.

Lesson 1, *continued*

5. Ask students to verbalize as many questions as they can think of about melting matter. As one student is sharing, the other student should write down the questions. Then, direct students to switch roles. As students discuss their questions, they should focus on developing questions, rather than on answering them.

6. In their pairs, instruct students to identify which questions are open-ended and which questions can be answered with a yes or no response. Ask students to try to change all their yes/no questions into open-ended questions. Students should also try to change their open-ended questions into yes/no questions.

7. In pairs, ask students to choose which three questions they are most interested in investigating in the remaining activities. Direct students to record these three questions. At the end of science instruction each day, ask students to revisit their questions and see if they can answer any portion of them.

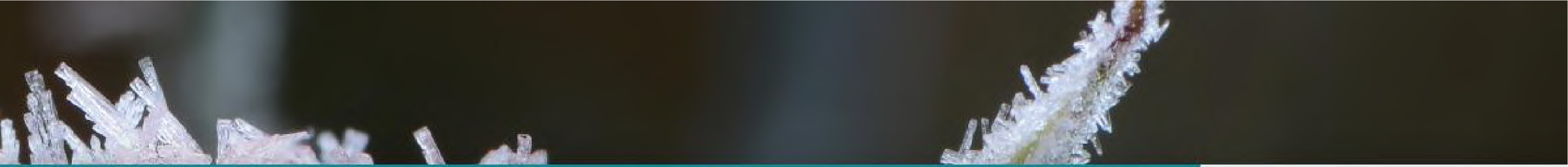
Student Page 176

Sample student responses shown.

I wonder . . .	*Answers may vary. What temperature would our classroom need to be for the ice cube to not melt?*
I wonder . . .	*Answers may vary. If I added something to the ice cube, would it melt slower?*
I wonder . . .	*Answers may vary. What would happen if we left the bowl of water on the hot plate overnight?*

Teacher Reflection

- Did this activity engage students?
- Did this activity allow students to generate their own questions?
- Would I introduce the concept of phase changes differently next year?



Activity 3
Evaluate Like a Scientist

20 min

What Do You Already Know About Changes to Matter?

Instructional Purpose

In this activity, students analyze data and use logical reasoning to communicate their prior knowledge of how changes of state do not affect the total mass of the matter present.

Scientific Context

The three states of matter are solid, liquid, and gas. Matter can be described by identifying properties in its current state. When matter changes state, the total number of particles in the matter stays the same.

Which States of Matter Do You Recognize?

Strategy

The item Which States of Matter Do You Recognize? provides a formative assessment of students' existing understanding of the three most common states of matter.

After students complete the item individually, discuss their answers as a class. Help students distinguish among the three states of matter and be able to provide additional examples of solids, liquids, and gases.

Sample student responses shown.

Look at the three pictures. Use the word bank to label each picture with the correct state of matter.

Air in Balloon: *gas*
Icicles: *solid*
Water: *liquid*

Describing the Three States of Matter

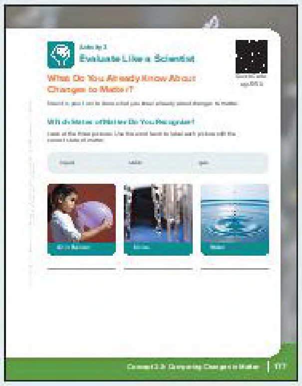
Strategy

The item Describing the Three States of Matter provides a formative assessment of students' existing conceptions of solid matter. Have students complete the item as a think-pair-share.

DIGITAL

Quick Code:
egst5150

Student Pages 177–178



Lesson 1, *continued*

At this point in the unit, students should feel comfortable with the term *property*. If students are struggling to recall what properties can describe different states of matter, choose an object in the classroom. Lead a class discussion to list properties of the object.

Student Page 178

Sample student responses shown.

What are some properties of an ice cube that tell you it is a solid? Write at least one property, and explain how it relates to an ice cube. Answers may vary. Like many solids, the ice cube is hard. It does not flow like a liquid might. It has a set shape. It takes up a fixed amount of space.

Changes in Matter

Strategy

The item Changes in Matter provides a formative assessment of students' existing knowledge of the effect of a change of state on the amount of matter.

Sample student responses shown.

Does the amount of matter change during a state change? Choose the best response to fill in the blank to complete the sentence.

When matter changes state, the total number of particles in the matter stays the same.

Teacher Reflection

Based on my data:

- What content do my students already know?
- What misconceptions do my students have at this point in the course?
- Are any of my students ready for extension at this point in the lesson?

Activity 4
Analyze Like a Scientist

10 min

Particles

Instructional Purpose

In this activity, students write a story depicting observations that could be conducted at the particle level inside a cup of tea.

Scientific Context

Particles are close together in solids and further apart in liquids. When particles are warmed, the particles move faster and spread out. Scientists refer to this change in behavior as particles "getting excited." When particles are cooled down, the particles move slower and come closer together.

Strategy

Begin this activity by asking students to imagine they could shrink to the scale of the tiny particles that make up matter and move around in a hot cup of tea. Students should reflect on the arrangement and motion, if any, of the particles they would see.

ASK

- *Imagine you are all particles in a cup of hot tea. Would the particles bump into one another? How close together are the particles?* *Yes the particles would bump into one another. The particles are close together, but not as close as if it were a solid.*
- *What would happen to the motion of the particles if the tea were warmed up? What would happen if the tea were cooled down?* *Answers may vary. If the tea warmed up, the particles would move faster and spread out. If the tea cooled down, the particles would move more slowly and come closer together.*

Sample student responses shown.

Imagine you could shrink to the scale of the tiny particles that make up matter and move around in a cup of tea. Write about or draw what you would experience. *Answers may vary.*

DIGITAL

Quick Code:
egst5151

Student Pages 179–180

Lesson 1, *continued*

Read aloud the text section Particles in Motion. During reading, stop to discuss the vocabulary terms highlighted in the text to clarify any misconceptions with the various forms of energy.

Provide students with a tray and marbles to elaborate on their responses to some of the posed questions. Encourage students to discuss how marbles or other visible particles can act as a model to describe and explain some of the properties and behavior of matter.

Student Page 180

Sample student responses shown.

How can marbles or other visible particles act as a model to describe and explain some of the properties and behavior of matter? Write or draw your ideas. Answers may vary.

Video Lesson 2

Quick Code:
egst5152

Activity 5
Investigate Like a Scientist

30 min

Hands-On Investigation: Changing States of Matter

Instructional Purpose

In this activity, students make predictions and then observe what happens when chocolate is cooled and then warmed.

Scientific Context

Matter exists in three common states—solid, liquid and gas. Matter can change from one state to another. It does so by either taking in or releasing energy. Changes in state follow a change in temperature and/or pressure. Understanding these changes and predicting when they are likely to occur can help scientists understand how substances will behave under different conditions.

Life Skills **Critical Thinking**

Activity Activator: Make a Prediction

Students will gain understanding about the way in which the state of matter can change due to a shift in temperature.

To prepare for the activity, place the chocolate pieces into the resealable bag.

Ask students to give examples of objects or materials that have states of matter that can easily change, such as water. Encourage students to elaborate on their responses by offering explanations about how and why the state of matter for each of these materials changes.

Ask students to brainstorm ways to change the chocolate from a solid into liquid. Introduce the term *melting* if students are unfamiliar with this word.

Sample student responses shown.

What are some examples of objects or materials that have states of matter that change? Answers may vary. Water can freeze and turn into a solid. Ice cream can melt and turn into a liquid. Butter can melt and turn into a liquid. Wax can melt and turn into a liquid.

What are some ways you could melt chocolate into a liquid? Answers may vary. We can hold it between our hands, put it in our mouths, or put it in a microwave or on a stove. We could also put it in the sun.

DIGITAL

Quick Code:
egst5153

Student Pages 181–183

Materials List
(per group)

- Plastic resealable bag
- Small pieces of chocolate, approximately 64 g
- Heat source (such as sunlight, lamp, or blow-dryer)
- Ice cubes in a small bowl, 4 or 5 (optional)

Safety

- Follow all lab safety guidelines.
- Do not eat or drink anything in the lab.
- Be careful when touching the cooled and heated objects.
- Follow proper disposal and cleaning procedures after the lab.

Activity Procedure: What Will You Do?

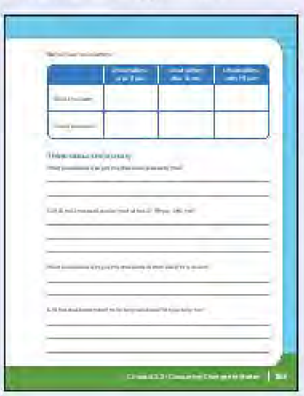
1. Distribute bags with a small amount of solid chocolate pieces to each group.
2. Allow students time to brainstorm ways that the solid pieces of chocolate could be melted into a liquid.
3. Explain to students that they will go outside and place the bag of chocolate in the sun. The bags should be laid on a paved area for the best exposure to heat. If it is not possible to go outside, you may choose to use another heat source, such as a lamp or blow-dryer.
4. Tell students to observe any changes that have occurred every 5 minutes until the chocolate is melted.
5. When the chocolate chips have melted into a liquid, direct students to describe what happened and why the change took place.
6. Return to the classroom and place the bag of melted chocolate in a cool location or on top of a small bowl of ice.
7. Tell students to observe any changes that have occurred every 5 minutes until the chocolate is solid again.
8. When the chocolate has formed back into a solid, direct students to describe what happened and why.

Analysis and Conclusions: Think About the Activity

Direct students to reflect on the investigation and answer the questions.

Sample student responses shown.

Student Page 183

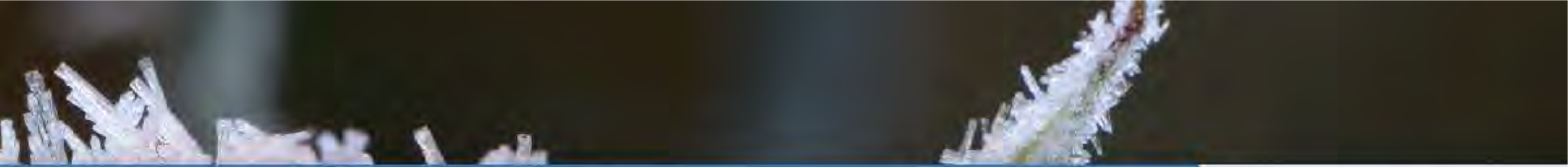


What was needed to get the chocolate pieces to melt? Answers may vary. We needed to heat them up.

Did all the chocolate pieces melt at once? Why or why not? Answers may vary. They did not all melt at once. Some pieces were smaller and melted faster.

What was needed to get the chocolate to form back into a solid? Answers may vary. We needed to make it cold or take the heat away.

Did the chocolate return to its original shape? Why or why not? Answers may vary. No, they did not return back into pieces because all the liquid just formed together in the shape of the bag. To make small pieces, you might need to pour the chocolate into a mold.



DIGITAL

Quick Code:
egst5154

Student Pages 184–185

Activity 6
Analyze Like a Scientist

15 min

Temperature and State of Matter

Instructional Purpose

In this activity, students obtain evidence from text and video to generate a model depicting the change in particle movement during a change of state.

Scientific Context

Particles in materials are always in motion. Models help scientists explain properties and behavior of materials by enabling them to visualize what is happening, even when components are too small to be seen with the eye.

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

Assign students to read the text section describing the effect of temperature on the state of matter. Students should underline evidence that they can use to support their response to the Can You Explain? question.

Then, direct students to watch the video Changes of State. After reading the text and watching the video, provide students with a Change Over Time Chart. Students should consider the chocolate they observed during the Hands-On Investigation: Changing States of Matter and generate a model depicting a change of state for the chocolate. Students' models should include some indication of changes in the movement of particles in the before and after sections.

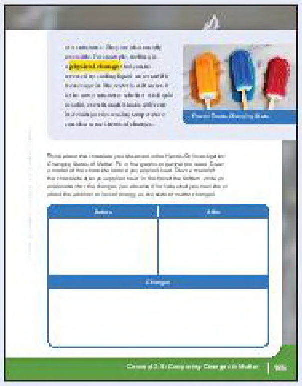
Sample student responses shown.

Underline evidence that you can use to answer the Can You Explain? question.

- *A substance's state depends partly on its temperature.*
- *As the particles of liquid water lose energy, they slow down until the liquid water becomes solid ice.*
- *As particles of solid ice gain energy, they move around more.*
- *Changes of state are often caused by changes in temperature.*

Lesson 2, *continued*

Student Page 185



Sample student responses shown.

Fill in the graphic organizer below. Draw a model of the chocolate before you applied heat. Draw a model of the chocolate after you applied heat. In the box at the bottom, write an explanation for the changes you observed. Include what you now know about the addition or loss of energy as the state of matter changed.

Before: *Answers may vary. Drawings should include particles arranged neatly and close to one another, indicating a solid state of matter.*

After: *Answers may vary. Drawings should include particles moving farther apart and in a less organized arrangement, indicating a liquid state of matter.*

Changes: *As they gained energy, the particles in the chocolate sped up and moved farther apart in a more disorganized arrangement.*

Video Lesson 3

Quick Code: egst5155

Activity 7

Observe Like A Scientist

20 min

What Is the Matter? Changing States

Instructional Purpose

In this activity, students access an interactive to collect information about water and the states of matter.

Scientific Context

Matter is always changing. Changes in state are physical changes and are reversible. Energy is always involved in changing states. Understanding how matter can change is essential to understanding science.

Strategy

Interactives offer a low-pressure and engaging environment for students to explore and test ideas. If your students cannot access the interactive, text has been provided to support learning. Students should use the interactive What's the Matter? Changing States to observe water in three states: solid, liquid, or gas.

Teacher Demonstration or Small-Group Activity

If you are using a teacher station computer with projection device, use the interactive to demonstrate the basic principles to the entire class. For example, use the animations in the Changing States interactive to begin a class discussion about the state of matter. Water is a substance with which all students are familiar. Therefore, all students should be able to take part in the discussion and contribute their own observations about a time when they have seen water changing states.

If resources allow, students can complete the activity in teams of three or four students. When finished, each group can summarize their findings on a chart in the front of the room. When all groups have finished, discuss the chart with the entire class.

Part 1: In the first part of What's the Matter? Changing States, students sort beakers containing different materials into three areas of a table, corresponding to the three states of matter: solid, liquid, and gas. If students cannot tell what is in each beaker, they can place their cursor over the beaker to reveal a pop-up label indicating the material in the beaker.

Part 2: The second part of What's the Matter? Changing States is an activity in which students examine how water changes state. The setting is a kitchen. The students start with liquid water in a beaker. Students have an initial choice of whether to add heat or remove heat from the liquid water. If students choose to add heat, the beaker is placed on the stove. The water

DIGITAL

Quick Code: egst5156

Student Pages 186–188

Lesson 3, *continued*

boils away. It has become water vapor and is now in the air in the kitchen. The students are then directed to remove heat from the water vapor in the air. This causes the water vapor to condense on the inside surfaces of the window. The water vapor changes state from water vapor (water in a gaseous state) back to liquid water. The liquid water is gathered back into the beaker. The liquid water is poured into an ice cube tray and placed inside a freezer where the water changes state from liquid water to solid ice. Finally, students add heat to the ice cubes to change the solid ice back to liquid water.

Student Page 188

Sample student responses shown.

Describe what happens to liquid water when you add heat (add thermal energy). How does this change affect particle movement? Answers may vary. The water gets warmer. After a while, the liquid water turns to water vapor. Water vapor is the gas state of water. The particles of water speed up and spread out to fill the room.

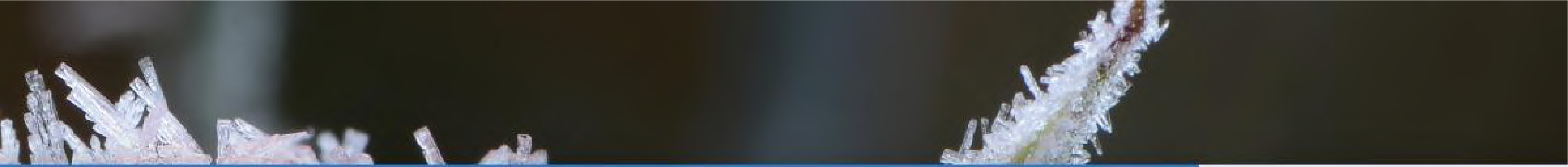
Describe what happens to liquid water when you remove heat (remove thermal energy). How does this change affect particle movement? Answers may vary. The temperature goes down. If the liquid water gets cold enough, it freezes. The liquid water turns into solid water, which is ice. The particles slow down and come together in an organized arrangement.

Describe what happens to solid ice when you add heat (add thermal energy). How does this change affect particle movement? Answers may vary. The ice melts and becomes liquid water. The particles speed up and spread out enough that they can move past one another and can be poured in the form of liquid water. If you keep adding heat, the liquid water will turn into water vapor, which is gaseous water.

MISCONCEPTION

The simulation shows water vapor as if it is visible. Gaseous water in form of water vapor or steam is not visible. We call the white, cloudlike mist coming from boiling water *steam*. However, steam is actually very hot water vapor and is invisible. If you look closely at the spout of a kettle of boiling water, you cannot see what is coming out right at the top of the spout. It is only after the hot water vapor hits the cooler air that you see steam that condenses into tiny water droplets, in effect forming a small cloud.

The activity talks about "adding heat" or "removing heat." In this activity, we are heating water by adding thermal energy. We lower the water's temperature by removing thermal energy. Heat is the transfer of the thermal energy; it is not something to be added or subtracted.



Activity 8
Observe Like a Scientist

10 min

Real-World Mixtures

Instructional Purpose

In this activity, students make observations and access prior knowledge of the properties of mixtures to describe how each image represents different mixtures.

Scientific Context

Mixtures and solutions are all around us. The air we breathe and some of the food we eat are mixtures. Mixtures allow materials to be combined and still retain their physical properties. Mixtures are used in cooking, building materials, and combining multiple materials into one product.

Life Skills **Endurance**

Strategy

Students may have used the term *mixture* in other subject areas, such as art or cooking. For example, the popular dish koshary is an example of a mixture. Access students' prior knowledge by asking them to share common definitions for the term *mixture*.

Present students with the three images: Pink Granite, Atmosphere, and Ocean Water. Label each image with a number, 1, 2, 3 (the images are already numbered in the Student Materials). Be sure to model how to read the pie chart Atmosphere correctly. Remind students that in a pie chart, the parts in color correspond to their labels, show quantity, and add up to become a whole.

ASK *Which of these pictures matches your definition of mixture?*
Answers may vary.

Students should hold up their fingers to indicate which picture they feel matches their definition of the term *mixture*. If they wish to choose two images, have them hold up fingers on each hand. If they think all three pictures match their definition, they can simply hold up both hands.

Share that each picture is an example of a real-world mixture.

Provide each table group with one of the three images. Have the table group work together to identify the parts that make up the substance. Students should label the number of parts they can find in the images. For the pink granite, students should observe that the different colors are different minerals. For the atmosphere pie chart, students should identify that the graph shows three substances that make up our atmosphere. For the ocean water, students should draw on prior knowledge that ocean water contains salt.

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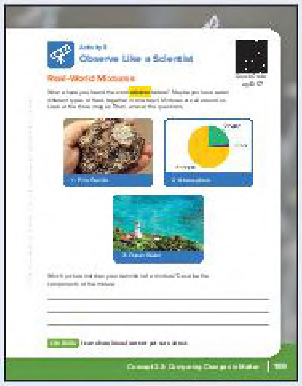
Quick Code:
egst5157

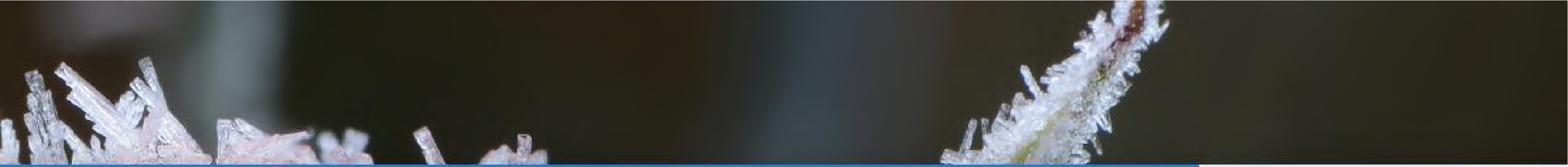
Student Page 189



Lesson 3, *continued*

Sample student responses shown.

Which picture matches your definition of a mixture? Describe the parts of the mixture. Answers may vary. All three match. For the pink granite, the parts can be recognized by the different colors. The atmosphere has different gases. The ocean water has water, salt, sea life, and other parts.



Activity 9
Analyze Like a Scientist

15 min

Mixtures

Instructional Purpose

In this activity, students obtain scientific information from a text about mixtures. Students then consider the best methods for separating the components of a mixture.

Scientific Context

Mixtures are materials that physically combine yet retain their chemical properties. Compounds, on the other hand, are chemically combined substances, such as water. While mixtures can be separated by their physical properties, compounds can only be separated chemically.

Strategy

To introduce the activity, display for students a cup of water and a small bowl containing two spoonfuls of salt. Ask students which common mixture (salt water) will be made if the two are combined. Add the salt to the water and stir. Ask students if they can see the salt in the water. Facilitate a discussion about if and how the salt could be extracted from the water.

Direct students to read the text Mixtures.

After students have finished reading, pair students with a partner. Ask pairs to discuss the Talk Together prompt.

MISCONCEPTION

Some students may think that you can always see the components of a mixture. In reality, the components in many mixtures are difficult or impossible to see without special equipment. Milk and orange juice are both examples of mixtures that have components that are hard to see. So is water from the tap, which is not pure water, but rather a mixture of water with dissolved minerals and gases.

Teacher Reflection

Are there additional techniques I could use to help my students better understand mixtures?

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Quick Code:
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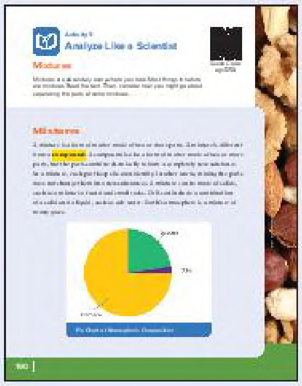
Student Pages 190–191



Lesson 4

Video Lesson 4

Quick Code: egst5159

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Quick Code: egst5160

Student Pages 192–196

Materials List

(per group)

- Scale or balance
- Spoons
- Weighing dishes
- Plastic resealable bags
- Baking soda
- Flour
- Cornstarch
- Epsom salts (magnesium sulfate)
- Water
- Vinegar
- Lemon juice
- Iodine
- Juice from purple cabbage
- Powdered lemonade or other drink powder
- Safety goggles (per student)
- Disposable gloves, 2 (per student)

Activity 10
Investigate Like a Scientist

45 min

Hands-On Investigation: Mixing It Up with Mass

Instructional Purpose

In this activity, students explore what happens to mass when they mix substances together.

Scientific Context

Mixtures and solutions occur often in our everyday lives. Being able to separate substances in a mixture helps us understand the properties of each substance. For example, you can use a magnet to separate a mixture of sand and metal paperclips. The mass of a mixture is the sum total of its parts. Mass is neither lost nor gained in a mixture.

Life Skills Critical Thinking

Teacher Preparation

A day or two prior to the activity, boil some red cabbage in water. Remove the cabbage and store the remaining liquid in a sealed jar.

The substances to be tested can be stored in sealed containers in a central location of the classroom for students to collect. You may choose to call one group up at a time to collect their materials. Alternatively, you may place a small amount of each substance in a small cup for each group.

If you do not have enough weighing dishes for each group, instruct students to wash and dry their weighing dish before moving to the next part of the activity.

Activity Activator: Make a Prediction

Students will develop an understanding of how mixing affects the properties of materials.

To introduce the activity, provide time for students to predict what will happen when various substances are mixed. Before starting this activity, remind students that they should never mix substances without checking first with a teacher or parent. Remind students that they are not to eat or drink any of the substances. Warn students that the iodine solution will stain skin and clothing.

Sample student responses shown.

How do you think combining substances affects the mass of a mixture? What do you predict will be the result of the investigation? Develop a claim about what you think is going to happen. Answers may vary. I think the total mass will be the sum of the masses of the two substances.

How will you investigate the question? Describe the plan that you will use to study the question and analyze your hypothesis. Answers may vary. I will find the masses of two substances. I will mix two substances together and measure the mass of the mixture. Then I will compare the sum of the masses of the two substances to the mass of the mixture.

Activity Procedure: What Will You Do?

Part 1: Mixing Solids

1. Instruct students to choose which two solids they would like to mix together. Make sure that students confirm their choices with you first.
2. You may need to review proper technique for weighing substances. Remind students that the amounts called for in the investigation are approximate and that students should record measurements with precision.
3. Students should place the weighing dish on the pocket scale and set the scale to read 0.0 g with the empty weighing dish on the scale. Tell students to add approximately 1 g of Solid 1 into the weighing dish. Students should record the mass and set the weighing dish aside.
4. Instruct students to place a new weighing dish on the scale and set the scale to read 0.0 g with the empty weighing dish on the scale. Tell students to add approximately 1 g of Solid 2 into the weighing dish. Students should record the mass and set the weighing dish aside.
5. Ask students to find the mass of a resealable plastic bag and record it.
6. Students should add Solid 1 and Solid 2 to the resealable bag and close the bag.
7. Instruct students to mix the two solids with their hands by massaging the resealable bag from the outside. Then, students should record their observations.
8. Tell students to find the mass of the resealable bag that contains the two solids and record it.

Safety

- Follow all lab safety guidelines.
- Tincture of iodine can stain hands and clothes. Wear gloves and be careful when using this substance.
- Be careful using sharp objects such as scissors, glass jars, and other equipment.
- Follow proper disposal and cleaning procedures after the lab.
- Wear proper safety attire, including closed-toe shoes, safety goggles, lab coats or aprons, and gloves.
- Tie back long hair.
- Do not eat or drink anything in the lab.

Part 2: Mixing Liquids

1. Instruct students to choose which two liquids they would like to mix together. Make sure that students confirm their choices with you first.
2. Students should place the weighing dish on the pocket scale and set the scale to read 0.0 g with the empty weighing dish on the scale. Have students add approximately 1 g of Liquid 1 into the weighing dish. Students should record the mass and set the weighing dish aside.
3. Instruct students to place a new weighing dish on the scale and set the scale to read 0.0 g with the empty weighing dish on the scale. Have students add approximately 1 g of Liquid 2 into the weighing dish. Students should record the mass and set the weighing dish aside.
4. Ask students to find the mass of a plastic resealable bag and record it.
5. Students should add Liquid 1 and Liquid 2 to the resealable bag and close the bag.
6. Instruct students to mix the two liquids with their hands by massaging the resealable bag from the outside. Then, students should record their observations.
7. Tell students to find the mass of the resealable bag that contains the two liquids and record it.

Part 3: Mixing Solids and Liquids

1. Instruct students to decide which solid and which liquid they would like to mix together. Make sure that students confirm their choices with you first.
2. Students should place the weighing dish on the pocket scale and set the scale to read 0.0 g with the empty weighing dish on the scale. Have students add approximately 1 g of the solid into the weighing dish. Students should record the mass and set the weighing dish aside.
3. Instruct students to place a new weighing dish on the scale and set the scale to read 0.0 g with the empty weighing dish on the scale. Have students add approximately 1 g of the liquid into the weighing dish. Students should record the mass and set the weighing dish aside.
4. Ask students to find the mass of a plastic resealable bag and record it.
5. Students should add the solid to the resealable bag and then the liquid. Students should then close the zipper bag.
6. Instruct students to mix the solid and liquid with their hands by massaging the resealable bag from the outside. Then, students should record their observations.

7. Tell students to find the mass of the resealable bag that contains the solid and the liquid and record it.
8. If time allows, direct students to repeat the data table and investigate other solid and liquid combinations.

Analysis and Conclusions: Think About the Activity

Once students have completed their investigations and cleaned up, facilitate a class discussion so that students may share their results with others. Record results of each type of mixture in a place where all students can see them. Explain that scientists conduct many trials in an experiment to ensure the validity of their results and look for patterns. By sharing their results with one another, students can treat the work of classmates as trials in a class experiment.

Sample student responses shown.

What did you learn from this investigation? Develop a conclusion for your investigation. Answers may vary. I learned that the mass of the mixture is the sum of the masses of the substances that make the mixture.

What happened to the properties of the substances when they were mixed? Answers may vary. When we chose two substances that did not react with one another, the properties of the two substances remained the same. For example, when flour and baking soda were mixed, nothing happened. They combined and each substance retained its physical properties. However, if we chose two substances that react with each other, the physical properties changed. For example, when baking soda and vinegar were mixed, a gas formed, causing bubbles. Sometimes properties of each substance changed because they reacted and formed a new compound. An example of a color change is when the iodine was added to the cornstarch. The compound formed a new substance that is black or blue.

What did you observe regarding the mass before and after mixing? Answers may vary. The mass is the same. Any mass that was missing was due to human error in procedure (loss of mass when transferring the substances). The mass is the sum of the individual substances.

What patterns do you observe in the class data collected in this activity? Answers may vary. Sometimes nothing happened, and the two substances remained the same. Sometimes, if the two substances reacted with each other, the physical properties changed. The color might change, or a gas might form. In all cases, the mass did not change.

Student Page 196

Video Lesson 5

Quick Code:
egst5162

Lesson 5

DIGITAL

Quick Code:
egst5161

Student Page 197

Activity 11
Evaluate Like a Scientist

10 min

Properties of Mixtures

Instructional Purpose

In this activity, students use their observations of the properties observed to identify characteristics of mixtures and construct explanations to describe the relationships between the parts of a mixture.

Scientific Context

Learning about the makeup of substances gives us knowledge about how things go together and how they can be taken apart.

Strategy

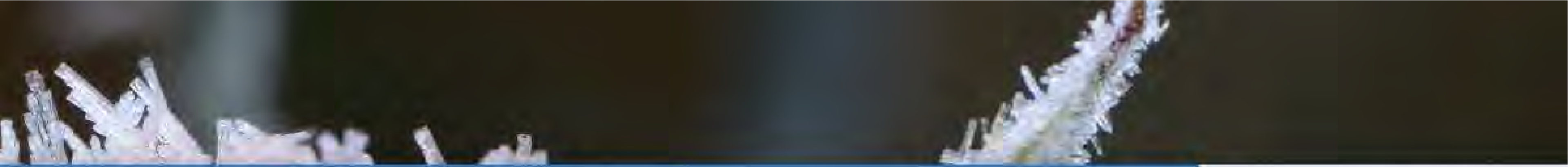
In the item Properties of Mixtures, students will identify characteristics of mixtures. Based on their answers, they will be able to explain the relationships of parts in a mixture.

Instruct students to work in pairs to discuss the reasons why each option might be correct or incorrect. After completing the item, ask students to provide examples to explain how specific mixtures have each of the properties they selected.

Sample student responses shown.

Which of the following properties do all mixtures have in common? Select all the choices that apply.
A. Are made of parts that can be separated
D. Are formed by physically combining two or more substances
F. Can be liquids, gases, or solids.

Provide examples that support your answer to the previous question.
Answers may vary. We saw that pink granite, our atmosphere, and ocean water have different substances in them that can be separated. In the Hands-On Investigation, we mixed solids and liquids. I observed that when powdered lemonade and flour were mixed, I could still see the different-colored particles.



Activity 12
Observe Like a Scientist

15 min

Physical Changes in Our Lives

Instructional Purpose

In this activity, students summarize their learning and use evidence to construct an explanation to describe real-world examples of physical changes.

Scientific Context

Changes are happening all around us every day. Physical changes do not result in a new substance. Understanding how things change helps us understand the world around us.

Strategy

Introduce students to the concept of physical changes by holding up a piece of paper. Ask students what you can do to change the paper. As students suggest ideas, such as crumpling it into a ball, cutting it, or tearing a piece off, perform those actions on the paper.

If a student suggests that you can burn the paper, ask if you will still have paper after it is burnt. *No, you will have ashes.*

ASK

- *Did you sharpen your pencil today? How did that change your pencil? Is it still a pencil?*
  Answers will vary. Students should note that some of the pencil (wood and lead/graphite) are left in the sharpener, but the pencil is still a pencil.
- *What are some other changes you observed today?*
  Answers will vary.

As students read and analyze a passage of text about a fictional trip to the market, encourage them to think of ways physical and other changes can be observed in everyday life.

After reviewing the correct answers, discuss as a class why certain statements do not involve physical changes. For example, why are baking pita bread and rust or tarnish forming not physical changes?

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Quick Code:
egst5163

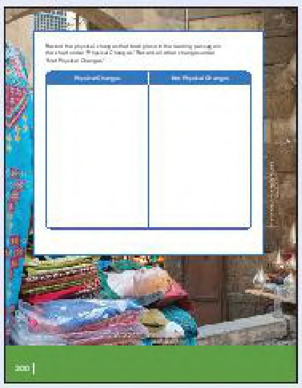
Student Pages 198–200

DIFFERENTIATION

Approaching Learners

If students struggle to identify the correct answers, advise students to underline all changes described in the text. For each change they underline, students should determine whether a new substance is being formed. If the answer is no, the change is physical.

Student Page 200

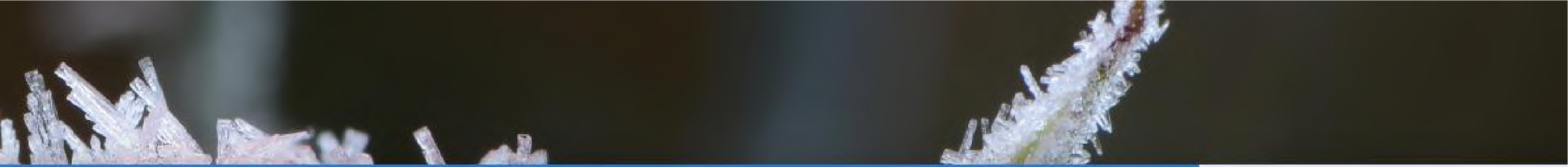


Sample student responses shown.

Record the physical changes that took place in the reading passage in the chart under "Physical Changes." Record all other changes under "Not Physical Changes."

Physical Changes: *cutting material to make a gallebaya, cutting fruits and vegetables into smaller pieces, wax melting, and broken shells*

Not Physical Changes: *making pita bread, tarnish forming on lamps*



Activity 13
Observe Like a Scientist

20 min

Chemical Changes in Matter

Instructional Purpose

In this activity, students observe chemical changes and then identify and communicate evidence that demonstrates whether specific observable phenomena are caused by chemical changes based on patterns in the matter.

Scientific Context

Learning about changes in substances is important for several reasons. Changes can be controlled to produce new materials, and we can learn more about a substance's properties.

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

Interactives offer a low-pressure and engaging environment for students to explore and test ideas. If your students cannot access the interactive, text has been provided to support learning.

Students will view real-world and simulated examples of chemical changes. Students should watch the video Chemical Changes in Matter and complete the interactive Things That Change (Chemical Change portion).

As students watch the video, they should look for clues that a change in matter is a chemical change. After viewing the video, direct students to complete the Chemical Change portion of the interactive Things That Change.

Once students have completed the video and the interactive, allow students time to discuss the Talk Together prompt with a partner. If time allows, call on students to share examples from their discussion with the class.

DIGITAL

Quick Code: egst5164

Student Page 201

Video Lesson 6

Quick Code:
egst5166

Lesson 6

DIGITAL

Quick Code:
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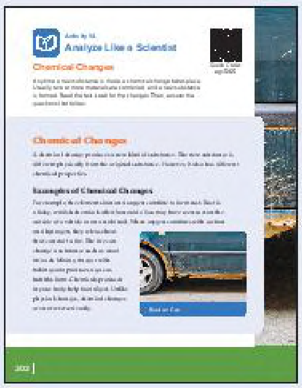
Student Pages 202–203



Activity 14
Analyze Like a Scientist

20 min

Chemical Changes

Instructional Purpose

In this activity, students read a text selection to obtain scientific information about how matter can undergo chemical changes and construct explanations for why changes can be classified as chemical.

Scientific Context

Chemical changes help us understand the properties of matter. These properties can help us identify unknown substances and help us predict how different substance might react with each other. This can lead to the development of new products.

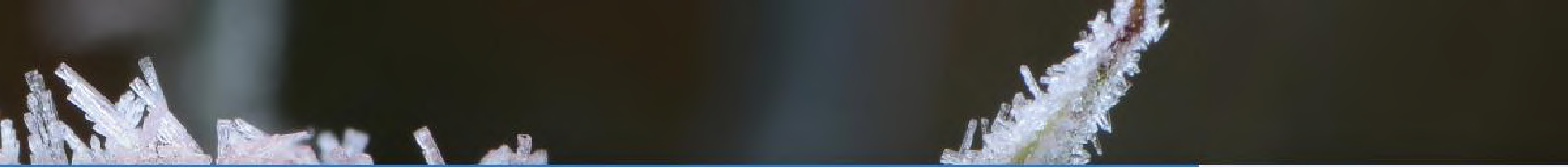
Strategy

In this activity, students should read the text section describing chemical changes.

Help students broaden their understanding of physical and chemical changes by posting a chart in the classroom where students can keep a running list of the two types of changes.

Before reading the text, set up a display in the classroom that shows a chemical change (for example, a burned sugar cube). Place two cards, one labeled "Physical Change" and the other labeled "Chemical Change," in front of the display. Cycle students through the display and allow them to vote on whether they think the example is a physical or chemical change by writing a tally mark on the appropriate card.

After reading the text, students should return to the display and conduct a second round of voting, using a different color pen or marker.



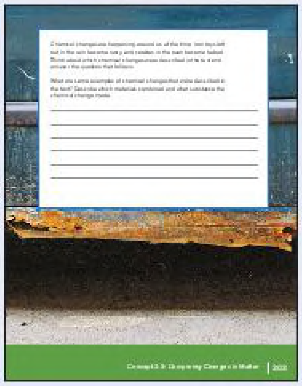
Sample student responses shown.

What are some examples of chemical changes that were described in the text? Describe which materials combined and what substance the chemical change made. *Iron and oxygen combine to make rust. Oxygen, carbon, and hydrogen can make a fire. Fire can change the wood into ash. Vinegar and baking soda produce gas bubbles, and chemicals in the body digest food.*

MISCONCEPTION

Students may think that physical changes cause matter to change into new substances, especially for changes of state. In fact, the identity of the original substance remains the same throughout these changes. For example, students may think that water changes into a new substance when it boils or freezes; however, solid, liquid, and gaseous water are all water.

Student Page 203



Lesson 6, *continued*

DIGITAL

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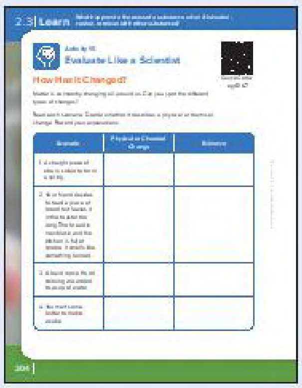
egst5167

Student Pages 204–205



Activity 15

Evaluate Like a Scientist

25 min

How Has It Changed?

Instructional Purpose

Students use evidence to construct an explanation to describe real-world examples of physical and chemical changes.

Scientific Context

Understanding the difference between physical and chemical changes is important. Some changes are obvious, but others may be more subtle. New materials can be created by understanding how substances react with each other.

Strategy

Before the activity begins, post a T-Chart that lists evidence of physical changes and chemical changes. Physical changes listed on the chart should include the following: change in size, change in shape, change in texture, and change in state of matter. Chemical changes listed on the chart should include the following: unexpected change in temperature, unexpected color change, formation of a gas (bubbles), formation of small solids (precipitates), light produced, and strong odor produced.

For each scenario, direct students to identify the change as a physical or chemical change and provide an explanation of the evidence for their rationale.

ASK

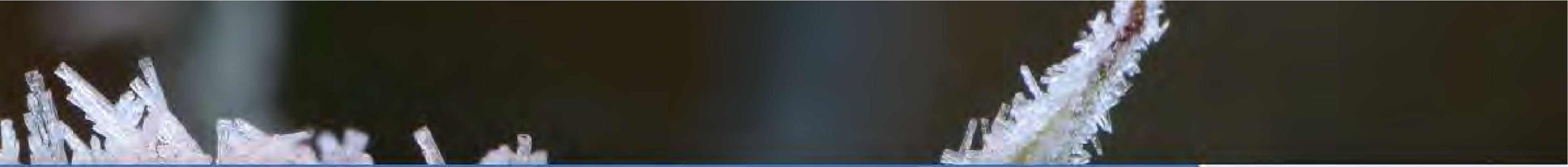
- *How do we know that a physical change has taken place?*
  Answers will vary. Students should know that a physical change does not alter the substance and can easily be reversed.
- *How do we know that a chemical change has taken place?*
  Answers will vary. Students should know that chemical changes cannot be easily reversed and can alter the substance.

Allow students to work in pairs and discuss their responses. After reviewing the answers, discuss as a class the explanations for each scenario.

DIFFERENTIATION

Advanced Learners

Place pictures or real objects that illustrate physical and chemical changes around the room and allow students to examine the items and look for clues as to what type of change may have occurred. Ask students to record their ideas about what change has taken place and provide an explanation of the evidence for their rationale.

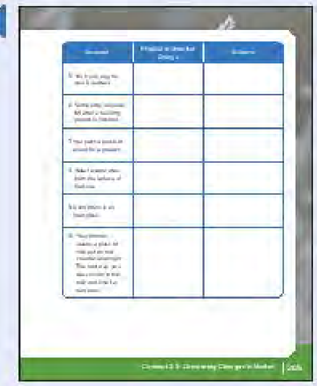


Sample student responses shown.

Read each scenario. Decide if it describes a physical or chemical change. Record your explanation.

1. A straight piece of wire is coiled to form a spring. *Physical; Only the shape changed.*
2. Your friend decides to toast a piece of bread, but leaves it in the toaster too long. The bread is now black, and the kitchen is full of smoke. It smells like something burned. *Chemical; The bread changes color (black). Smoke is something new formed. The burnt odor is new.*
3. A few drops of food coloring are added to a cup of water. *Physical; Not an "unexpected" color change. The water is the same color as the food coloring. Nothing new formed.*
4. *You melt some butter to make a cake.* *Physical; The butter changed state from solid butter to liquid butter. Nothing new formed.*
5. You fry an egg for your breakfast. *Chemical; There are color changes in the whites and the yolk. Cooking cannot be easily reversed.*
6. Some rusty nails are left after a building project is finished. *Chemical; Rust is something new that was not on the nails originally.*
7. You paint a piece of wood for a project. *Physical; Nothing new forms. The wood is still wood. The wood is the color of the paint.*
8. Water evaporates from the surface of the Nile. *Physical; Evaporation is a change of state from liquid water to a gas.*
9. Sand flows in an hourglass. *Physical; The sand changes shape in the container. Nothing new is formed.*
10. Your brother leaves a glass of milk out on the counter overnight. The next day, you see chunks in the milk and smell a bad odor. *Chemical; Solid chunks formed, which were not there originally. A bad smell is produced.*

Student Page 205



Video Lesson 7

Quick Code: egst5171

Lesson 7

DIGITAL

Quick Code: egst5168

Student Pages 206–208

Activity 16

Record Evidence Like a Scientist

15 min

Melting Matter

Instructional Purpose

In this activity, students return to the questions posed at the beginning of the concept and reconsider what they know now. Students construct a scientific explanation about the Investigative Phenomenon Melting Matter and the Can You Explain? question.

Scientific Context

The process of writing a scientific explanation using evidence to support a claim is a key step in students constructing scientific knowledge that they can then use and apply.

Life Skills **Creativity**

Strategy

Display the Investigative Phenomenon Melting Matter and the Can You Explain? question. Ask students to discuss and share with the class or a partner their explanation for the Investigative Phenomenon Melting Matter.

Sample student responses shown.

How can you describe melting matter now? Answers may vary. Students should reference thermal energy and a physical change from solid to liquid.

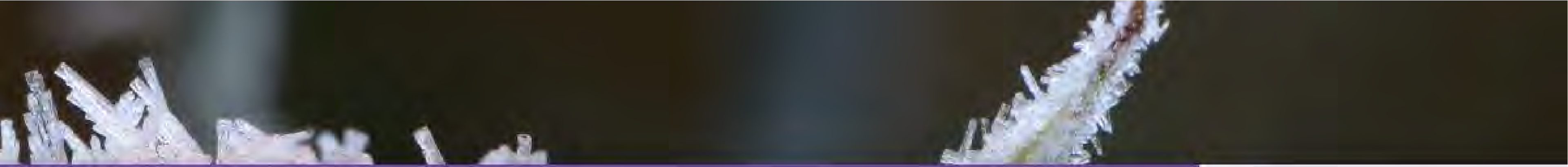
How is your explanation different from before? Answers may vary.

After allowing students to discuss,

ASK *How can this explanation help you answer the Can You Explain? question?*

Can You Explain?

What happens to the mass of a substance when it is heated, cooled, or mixed with other substances?



As students would have already reviewed sample scientific explanations in earlier units, they should be familiar with the process of using evidence to support a claim. You may want to review the following:

A **claim** is a one-sentence answer to the question you investigated. It answers, What can you conclude? It should not start with *yes* or *no*.

My claim: *The mass of a substance does not change when the substance is heated, cooled, or mixed with other substances.*

Evidence must be:

- Sufficient—Use enough evidence to support the claim.
- Appropriate—Use data that support your claim. Leave out information that doesn't support the claim.

At this level, students should be able to construct a scientific explanation that includes reasoning as part of the explanation.

Reasoning ties together the claim and the evidence, and:

- Shows how or why the data count as evidence to support the claim.
- Provides the justification for why this evidence is important to this claim.
- Includes one or more scientific principles that are important to the claim and evidence.

Sample student responses shown.

Evidence: *We observed that when an ice cube warms and changes to liquid water, the mass remains the same. Sometimes matter changes form and mass escapes into the air as a gas during physical or chemical changes. However, if that gas was collected and cooled, as we saw in the interactive, the mass would be the same as when we started. We collected data during an investigation in which we mixed substances in sealed bags so that nothing could escape. We recorded the mass of the substances before and after we mixed them together.*

Student Page 207

Lesson 7, *continued*

After providing scaffolding to students, allow them time to construct a full scientific explanation. Students can write, draw, or orally describe their claim, evidence, and scientific explanation that includes reasoning.

If time allows, invite students to share their claim, evidence, and scientific explanation with reasoning. Student answers in all sections will vary. Sample student answers are provided as a benchmark for possible responses.

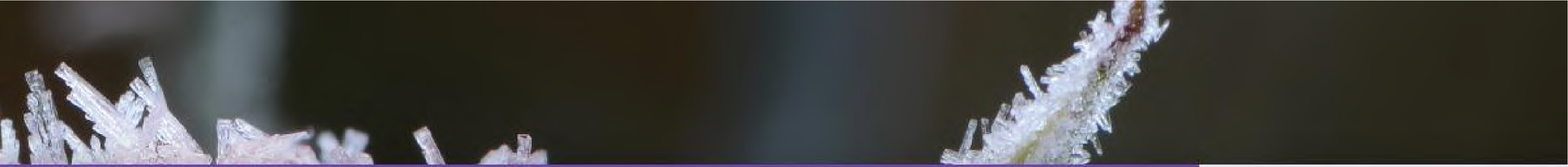
Sample student responses shown.

Student Page 208

Scientific explanation with reasoning: *Temperature is the main factor that causes changes in matter. When energy is added in the form of heat, particles move more quickly and spread out. When energy is released, the particles slow down and become more tightly packed and organized once again. These changes to the particles result in changing states. No matter the state of the matter though, mass is constant. When we mixed substances in different states, the combined mass was equal to the total of the two materials before mixing.*

Teacher Reflection

- How has my students' construction of scientific explanations improved from earlier in the course?
- How did I provide scaffolding for students to construct their scientific explanations?
- How do I know my students are ready to apply the core content knowledge to another context?



STEM in Action

Activity 17
Analyze Like a Scientist

20 min

Plenty of Water, but None to Drink

Instructional Purpose

In this activity, students read a text and watch a video to learn about the process of desalination. Students then discuss careers associated with turning seawater into drinking water.

Scientific Context

Desalination is the process of turning salt water into fresh water. In many parts of the world, people lack access to drinking water. Desalination could be a way to solve this problem. However, the current process is expensive, requires a great deal of energy, and can be harmful to the environment.

Strategy

Show students a picture of Earth. Draw attention to the ratio of water to land. Explain to students that nearly 800 million people lack access to clean drinking water. Ask students to consider possible solutions to this problem. Facilitate a discussion about how a worldwide water shortage could be solved, using available water resources on our planet.

Ask students to read the text and watch the video. After reading, pair students with partners to discuss the Talk Together prompt.

If time allows, once students have finished making lists with their partners, ask students to share their ideas with the class. Create a class list of careers that are involved in desalinization.

DIGITAL

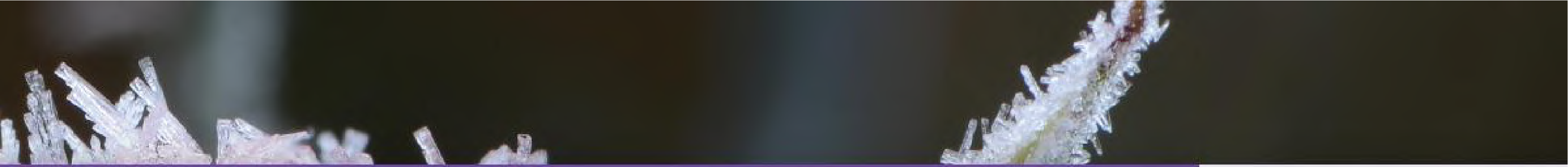
Quick Code:
egst5169

Student Pages 209–211

Lesson 7, *continued*

ENTREPRENEURSHIP

Students may not be familiar with the idea of desalination; however, it is a booming business in many areas of the world. The Middle East region accounts for more than 60% of the world's total desalination capacity. A major concern with the costly process of desalination is managing resources and factoring in costs with regard to overall output. Entrepreneurs could be helpful in thinking of ways to innovate to both improve the desalination process and to use existing, available water more efficiently. Encourage students to think of ways they could be innovative when thinking about water use and purification.



Review and Assess

Activity 18
Evaluate Like a Scientist

10 min

Review: Changes to Matter

Instructional Purpose

The final activity in the concept asks students to review and explain the main ideas of changes in matter, temperature, and mass.

Scientific Context

As part of the concept review, students reflect upon and synthesize knowledge acquired throughout the concept. This activity helps students practice sharing their scientific knowledge and findings with others and serves as a summative assessment.

Strategy

Now that students have achieved this concept's objectives, direct them to review the key ideas online. You may also assign students the summative assessment for this concept.

In the summative concept assessment, students are asked to summarize how changes in state affect mass, identify real-world examples of mixtures, and define characteristics of mixtures. Students are asked to use evidence from the concept activities to determine whether the text describes a physical or a chemical change.

Sample student responses shown.

Discuss temperature and how it affects matter. Write about some real-world examples of changes in matter. Reflect on the different ways that substances can combine. Explain the differences between physical and chemical changes. *Answers may vary.*

Teacher Reflection

- How many of my students met the performance expectation statements for this concept?
- For students who did not meet the performance expectations, what are my next steps?

DIGITAL

Quick Code:
egst5170

Student Page 212

Lesson 8

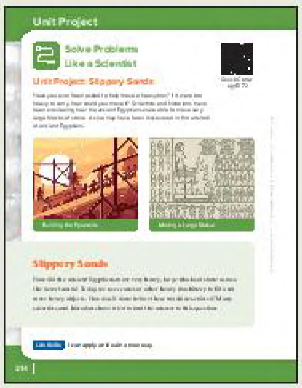
Video Lesson 8

Quick Code: egst5175

DIGITAL

Quick Code: egst5172

Student Pages 214–217



Materials List
(per group)

- Sand
- Water
- String
- Graduated cylinder or measuring cup
- Balance
- Tray
- Heavy wood block or brick
- Spring scale (optional)
- Spray bottle (optional)

Unit Project

Solve Problems Like a Scientist

45 min

Unit Project: Slippery Sands

Instructional Purpose

The Unit Project allows students to return to the Anchor Phenomenon for the unit, Sands of Time, and apply the performance expectations for the unit to solve or research a problem. This project challenges students to apply their understanding about the properties of matter to test a strategy that the ancient Egyptians may have used to build the pyramids.

Scientific Context

Properties of materials help us understand characteristics that are unique to that material. This understanding can be especially important to engineers who build roads and buildings.

Life Skills **Creativity**

Strategy

Video resources are designed to help students meet instructional goals. If your students cannot access the videos, text has been provided to support learning.

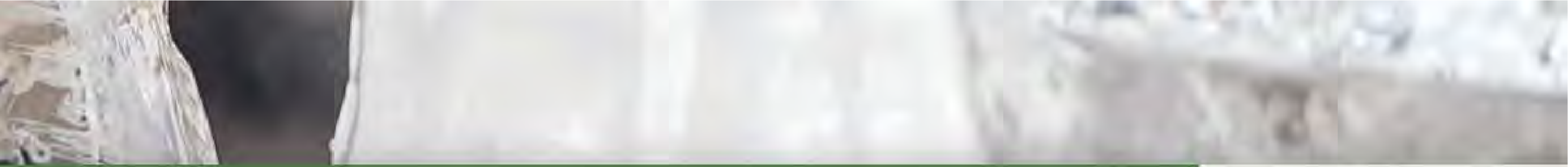
This summative assessment provides students with the opportunity to investigate and explain observations made about adding water to sand to make it more slippery. Students should work in pairs to complete this activity.

Show students the video Sand, Friction, and Building the Pyramids, and read the accompanying text. Discuss how scientists and historians developed this theory.

ASK *How do we know which theory is correct: water was used as part of a ceremony, or water was used to reduce friction?*
We will probably never know since it was so long ago, but scientists tested this theory about friction and the results indicate that it is possible.

Help students design an experiment in which they use a control sample of sand that is not wet and an experimental sample of sand that is wet.

For quantitative measurements, provide measuring cups or graduated cylinders to measure the amount of water added. If available, use a spring scale to measure the force used to pull the block across the sand. Model how to read the spring scale if students are not familiar with it. Use a balance to measure the sand.



The sand can be spread out on a cardboard box, tray, or even on the cement outside. A spray bottle may be used to evenly distribute the water across the sand.

Students should share their results with the class and discuss the optimum amount of water to move the block the most efficiently. Encourage students to apply knowledge about the properties of matter in explaining their results.

Sample student responses shown.

With your partner, decide on the question you will answer in this investigation. Record your question. *Answers may vary. Will adding 100 mL of water make the sand more slippery?*

With your partner, discuss possible hypotheses that provide an answer to your investigative question. Record one hypothesis that you will test in this investigation. *Answers may vary. We think that adding 100 mL of water will make the sand more slippery and easier to move the wooden block.*

Discuss the procedure that you will follow in your investigation. Write out the steps. Then, have your teacher approve your procedure before you begin. *Answers may vary. Sample procedure:*

1. *Place the wood block on the sand.*
2. *Tie a string around the block.*
3. *Try to pull the block over the sand and record results.*
4. *Add 100 mL of water to the sand.*
5. *Try to pull the block again and record results.*

Carry out your investigation, collect data and observations, and record these in the space provided. *Answers may vary. Student data should include any data and observations the procedure dictated would be collected. Students should organize their data clearly in graphic organizers, such as charts.*

Student Pages 216–217

Primary 5 Resources

Concept Assessment
Unit 1, Concept 1: Plant Needs

Name ______________________________ **Date** ____________________

Instructions
Please answer each question carefully.

1. Plants use energy from sunlight to make their own food from water and carbon dioxide through a process called ______.

   A. reproduction

   B. photosynthesis

   C. germination

   D. respiration

2. Plants use energy from ______ to make their own food from water and carbon dioxide.

   A. batteries

   B. fire

   C. sunlight

   D. wind

3. Duckweed are tiny, floating plants found on the top of lakes and ponds. How do they get the energy that they use as food?

   A. They use photosynthesis to change light energy into food energy.

   B. They are so small that they can absorb the energy they need from the water.

   C. They are parasites that attach to fish to absorb the energy they need.

   D. They eat other plants.

Concept Assessment
Unit 1, Concept 1: Plant Needs

Name ______________________ **Date** ______________

4. Which of the following is taken in from the atmosphere through leaves to make food for a plant?

- **A.** carbon dioxide
- **B.** glucose
- **C.** oxygen
- **D.** hydrogen

5. Which part of the plant transports food from the leaves to other parts of the plant?

- **A.** xylem
- **B.** rootlets
- **C.** chloroplasts
- **D.** phloem

6. Which statement is not an accurate representation of plant activity?

- **A.** Photosynthesis occurs in tiny structures called chloroplasts.
- **B.** Sugars are moved to the leaves from the roots through the stem.
- **C.** Roots carry water and nutrients from the soil to the rest of the plant.
- **D.** Plants use sunlight, nutrients from the soil, water, and oxygen to make the food they need.

7. Photosynthesis occurs in the chloroplasts of plant cells. Which gas is released during this process?

- **A.** nitrogen
- **B.** hydrogen
- **C.** oxygen
- **D.** carbon dioxide

Concept Assessment
Unit 1, Concept 1: Plant Needs

Name ______________________ **Date** ______________

8. Tamer planted a flowering plant in a pot. He used rich soil and watered it regularly. He then placed the plant into a plastic bag and hid it in the closet for a week. He still watered the plant daily, but the plant did not survive. The plant did not survive because he did not provide ______, which are basic needs of the plant.

- **A.** air and light
- **B.** water and fertilizer
- **C.** pollen and seeds
- **D.** warmth and mulch

9. Which part of the plant plays a similar role in keeping the plant alive to the circulatory system in humans?

- **A.** stem
- **B.** roots
- **C.** leaves
- **D.** transport system

10. A long, dry season in a rainforest produced below-average rainfall, and some plant populations declined afterwards. Why did the change in weather pattern affect plant growth in the region?

- **A.** The dry season caused the temperature in the area to drop.
- **B.** The dry season caused the soil to become less nutrient-rich.
- **C.** The dry season reduced the amount of water in the ground.
- **D.** The dry season caused less sunlight to reach the ground.

Concept Assessment
Unit 1, Concept 2: Energy Flow in Ecosystems

Name ______________________________ **Date** ________________

Instructions
Please answer each question carefully.

1. All ______ need a source of energy.

- **A.** oceans
- **B.** minerals
- **C.** rocks
- **D.** organisms

2. Plants are ______ that get energy from the sun to make their own food.

- **A.** decomposers
- **B.** consumers
- **C.** producers
- **D.** nonliving

3. Which organism gets energy from another organism?

- **A.** a rabbit
- **B.** a cactus
- **C.** a flower
- **D.** an acacia tree

4. A vole eats grass and seeds, and an owl eats the vole. This is an example of a ______.

- **A.** carnivore
- **B.** food web
- **C.** herbivore
- **D.** food chain

Concept Assessment
Unit 1, Concept 2: Energy Flow in Ecosystems

Name ____________________ **Date** ____________

5. What is the complex interactions of producers, consumers, and predators called?

- **A.** a niche
- **B.** a food chain
- **C.** a food web
- **D.** a habitat

6. Food chains include producers, consumers, and decomposers. Which of the following has an example of all three?

- **A.** nuts, squirrel, fungus
- **B.** leaf, eagle, robin
- **C.** seeds, mouse, owl
- **D.** fly, spider, praying mantis

7. A food web shows the ______.

- **A.** nonliving features in the environment.
- **B.** feeding relationships between organisms.
- **C.** the way that heat is trapped in an environment.
- **D.** substances that contaminate the atmosphere.

8. Wolves prefer to hunt elk for food. If the elk population in an area declines because of hunting by humans, the wolves would most likely ______.

- **A.** start to attack human hunters.
- **B.** find an area with more elk.
- **C.** choose another food to eat.
- **D.** become endangered and then extinct.

Concept Assessment
Unit 1, Concept 2: Energy Flow in Ecosystems

Name ______________________________ **Date** ____________________

9. Energy in the form of food flows from one organism to another. Which is the correct direction of this energy flow?

A. from producers to consumers

B. from consumers to producers

C. back and forth between consumers and producers

D. there is no energy flow between producers and consumers

10. Identify the correct order of this food chain.

A. plant → hawk → snake → mouse

B. plant → mouse → hawk → snake

C. plant → mouse → snake → hawk

D. hawk → snake → mouse → plant

Concept Assessment
Unit 2, Concept 1: Matter in the World around Us

Name ________________________ **Date** ________________

Instructions
Please answer each question carefully.

1. How are solids unique from other forms of matter?

- **A.** Solids take the shape of any container.
- **B.** Solids have a definite size and shape.
- **C.** Solids can be poured.
- **D.** Solids fill whatever container they are put in.

2. Match each of the descriptions to the correct related example of matter from the word bank.

ice	water	water vapor

________________ **A.** takes the shape of container, can flow, and particles are not so near to each other

________________ **B.** has fixed shape, and particles are very near to each other

________________ **C.** does not have a fixed shape, takes up all the space of the container, and particles are far apart

3. All matter is made of ______.

- **A.** cells
- **B.** proteins
- **C.** particles
- **D.** muscles

Concept Assessment
Unit 2, Concept 1: Matter in the World around Us

Name ______________________ **Date** ______________

4. What makes gases different from other states of matter? Choose all that apply.

- **A.** Gases can be poured.
- **B.** Gases have a definite shape.
- **C.** Gases fill the shape of any container they are put in.
- **D.** Gases do not have a definite shape.

5. Which two properties of matter make it possible to make star-shaped ice cubes? Choose two answers.

- **A.** Liquids take the shape of whatever container they are poured into.
- **B.** Gases spread out to fill any container.
- **C.** Solids have a definite shape.
- **D.** Gases have no definite shape.

6. A group of classmates would like to put on a play to act out the states of matter. They will use their bodies to model the arrangement of particles in a solid. Choose the answer that describes how they could use their bodies to model a solid correctly.

- **A.** The students would stand with their bodies spread out far apart around the room.
- **B.** The students would stand with some space between each other, near to one another but not close enough that they could reach out and touch another student.
- **C.** Some students would remain in the classroom, while others would move into the hallway.
- **D.** The students would stand very closely together, packed tightly into a small area.

Concept Assessment
Unit 2, Concept 1: Matter in the World around Us

Name ______________________________ **Date** ____________________

7. There are three different states of water. The following images are examples of water in its different states. Next to each example image, write the letter of the explanation that describes its current state.

A. Tightly packed water particles that retain a shape.

B. Loosely packed water particles that take on the shape of their container.

C. Loosely packed water particles that do not have a definite shape or volume

 ______

 ______

 ______

 ______

 ______

 ______

Concept Assessment
Unit 2, Concept 1: Matter in the World around Us

Name ____________________ **Date** ____________

8. Matter is ______.

- **A.** anything in the world
- **B.** anything that has mass and takes up space
- **C.** only water in different states
- **D.** only solids

9. Matter can change from one state to another.

- **A.** true
- **B.** false

10. How can a model be helpful?

- **A.** Models give us step-by-step instructions about how to build something.
- **B.** Models make something look better than it does in real life.
- **C.** Models always make something smaller than it is in real life.
- **D.** Models can help us see things that are too small or too big to observe.

Concept Assessment
Unit 2, Concept 2: Describing and Measuring Matter

Name ______________________ **Date** ______________

Instructions
Please answer each question carefully.

1. A scientist is comparing three common materials. She has a sample of each material that is exactly 10 cc (cubic centimeters). Using what you know about matter, fill in the table with the properties of each material.

smooth	rough	brown	gray
silver	26g	6g	10g

Material	Texture	Color	Mass of 10cc sample
Cardboard			
Large Coin			
Granite Rock			

2. A student wants to make a shelf that will display some objects in her room. She needs to decide which material would make the best shelf. She also wants to be sure the shelf will securely hang on the wall. She needs to make sure the shelf will both fit all her things and safely hold up what she wants to put on it. Which characteristics of the shelf's matter are critical for her to measure? Choose all that apply.

   A. length

   B. color

   C. mass

   D. texture

Concept Assessment
Unit 2, Concept 2: Describing and Measuring Matter

Name ______________________ **Date** ______________

3. Which of the following would be a scientific description of the properties of a crystal of salt?

A. It is beautiful.

B. It could be salt.

C. I'm not sure what it is.

D. It is solid, square, and clear.

4. You can describe fabric as rough, fuzzy, smooth, or silky. Which property of matter is this?

A. density

B. shape

C. mass

D. texture

5. Read the text. Underline the words and phrases that describe the properties that make cardboard a good choice for making a box.

All materials have advantages and disadvantages. Materials may be strong or weak. Some materials are better for some uses than others. Heavy rocks and metals work for many uses. Paper and cardboard work for other uses. Cardboard is a better material for a box than glass. Cardboard is thin and flexible. However, it can get ruined if it gets wet. Because cardboard is not rigid, it is easy to cut and fold. However, it may break when it is used to hold very heavy items.

Concept Assessment
Unit 2, Concept 2: Describing and Measuring Matter

Name ______________________________ **Date** ____________________

6. Which of the following are two examples of physical properties?

A. ability to burn

B. ability to rust

C. blue

D. round

7. ______ changes describe how matter interacts with other matter.

A. chemical

B. physical

C. melting

D. breaking

8. Mass is a measurement of ______.

A. the odor of matter

B. the length of matter

C. the amount of matter

D. the color of matter

9. Volume is the amount of ______ that matter takes up.

A. time

B. space

C. temperature

D. water

10. Gas has mass.

A. true

B. false

Concept Assessment
Unit 1, Concept 1: Plant Needs

Name ______________________ **Date** ______________

Instructions
Please answer each question carefully.

1. Plants use energy from sunlight to make their own food from water and carbon dioxide through a process called ______.
   - **A.** reproduction
   - **B.** photosynthesis
   - **C.** germination
   - **D.** respiration

2. Plants use energy from ______ to make their own food from water and carbon dioxide.
   - **A.** batteries
   - **B.** fire
   - **C.** sunlight
   - **D.** wind

3. Duckweed are tiny, floating plants found on the top of lakes and ponds. How do they get the energy that they use as food?
   - **A.** They use photosynthesis to change light energy into food energy.
   - **B.** They are so small that they can absorb the energy they need from the water.
   - **C.** They are parasites that attach to fish to absorb the energy they need.
   - **D.** They eat other plants.

Concept Assessment
Unit 1, Concept 1: Plant Needs

Name ______________________ **Date** ______________

4. Which of the following is taken in from the atmosphere through leaves to make food for a plant?
   - **A.** carbon dioxide
   - **B.** glucose
   - **C.** oxygen
   - **D.** hydrogen

5. Which part of the plant transports food from the leaves to other parts of the plant?
   - **A.** xylem
   - **B.** rootlets
   - **C.** chloroplasts
   - **D.** phloem

6. Which statement is not an accurate representation of plant activity?
   - **A.** Photosynthesis occurs in tiny structures called chloroplasts.
   - **B.** Sugars are moved to the leaves from the roots through the stem.
   - **C.** Roots carry water and nutrients from the soil to the rest of the plant.
   - **D.** Plants use sunlight, nutrients from the soil, water, and oxygen to make the food they need.

7. Photosynthesis occurs in the chloroplasts of plant cells. Which gas is released during this process?
   - **A.** nitrogen
   - **B.** hydrogen
   - **C.** oxygen
   - **D.** carbon dioxide

Concept Assessment
Unit 1, Concept 1: Plant Needs

Name ______________________ **Date** ______________

8. Tamer planted a flowering plant in a pot. He used rich soil and watered it regularly. He then placed the plant into a plastic bag and hid it in the closet for a week. He still watered the plant daily, but the plant did not survive. The plant did not survive because he did not provide ______, which are basic needs of the plant.
   - **A.** air and light
   - **B.** water and fertilizer
   - **C.** pollen and seeds
   - **D.** warmth and mulch

9. Which part of the plant plays a similar role in keeping the plant alive to the circulatory system in humans?
   - **A.** stem
   - **B.** roots
   - **C.** leaves
   - **D.** transport system

10. A long, dry season in a rainforest produced below-average rainfall, and some plant populations declined afterwards. Why did the change in weather pattern affect plant growth in the region?
    - **A.** The dry season caused the temperature in the area to drop.
    - **B.** The dry season caused the soil to become less nutrient-rich.
    - **C.** The dry season reduced the amount of water in the ground.
    - **D.** The dry season caused less sunlight to reach the ground.

Concept Assessment
Unit 1, Concept 2: Energy Flow in Ecosystems

Name ______________________________ Date ________________

Instructions
Please answer each question carefully.

1. All ______ need a source of energy.
   - **A.** oceans
   - **B.** minerals
   - **C.** rocks
   - **D.** organisms

2. Plants are ______ that get energy from the sun to make their own food.
   - **A.** decomposers
   - **B.** consumers
   - **C.** producers
   - **D.** nonliving

3. Which organism gets energy from another organism?
   - **A.** a rabbit
   - **B.** a cactus
   - **C.** a flower
   - **D.** an acacia tree

4. A vole eats grass and seeds, and an owl eats the vole. This is an example of a ______.
   - **A.** carnivore
   - **B.** food web
   - **C.** herbivore
   - **D.** food chain

Concept Assessment
Unit 1, Concept 2: Energy Flow in Ecosystems

Name ______________________________ Date ________________

5. What is the complex interactions of producers, consumers, and predators called?
   - **A.** a niche
   - **B.** a food chain
   - **C.** a food web
   - **D.** a habitat

6. Food chains include producers, consumers, and decomposers. Which of the following has an example of all three?
   - **A.** nuts, squirrel, fungus
   - **B.** leaf, eagle, robin
   - **C.** seeds, mouse, owl
   - **D.** fly, spider, praying mantis

7. A food web shows the ______.
   - **A.** nonliving features in the environment.
   - **B.** feeding relationships between organisms.
   - **C.** the way that heat is trapped in an environment.
   - **D.** substances that contaminate the atmosphere.

8. Wolves prefer to hunt elk for food. If the elk population in an area declines because of hunting by humans, the wolves would most likely ______.
   - **A.** start to attack human hunters.
   - **B.** find an area with more elk.
   - **C.** choose another food to eat.
   - **D.** become endangered and then extinct.

Concept Assessment
Unit 1, Concept 2: Energy Flow in Ecosystems

Name ______________________________ Date ________________

9. Energy in the form of food flows from one organism to another. Which is the correct direction of this energy flow?
   - **A.** from producers to consumers
   - **B.** from consumers to producers
   - **C.** back and forth between consumers and producers
   - **D.** there is no energy flow between producers and consumers

10. Identify the correct order of this food chain.
    - **A.** plant → hawk → snake → mouse
    - **B.** plant → mouse → hawk → snake
    - **C.** plant → mouse → snake → hawk
    - **D.** hawk → snake → mouse → plant

Concept Assessment
Unit 2, Concept 1: Matter in the World around Us

Name ______________________ Date ______________

Instructions
Please answer each question carefully.

1. How are solids unique from other forms of matter?
   - **A.** Solids take the shape of any container.
   - **B.** Solids have a definite size and shape.
   - **C.** Solids can be poured.
   - **D.** Solids fill whatever container they are put in.

2. Match each of the descriptions to the correct related example of matter from the word bank.

ice	water	water vapor

water **A.** takes the shape of container, can flow, and particles are not so near to each other

ice **B.** has fixed shape, and particles are very near to each other

water vapor **C.** does not have a fixed shape, takes up all the space of the container, and particles are far apart

3. All matter is made of ______.
   - **A.** cells
   - **B.** proteins
   - **C.** particles
   - **D.** muscles

Concept Assessment
Unit 2, Concept 1: Matter in the World around Us

Name ______________________ Date ______________

4. What makes gases different from other states of matter? Choose all that apply.
   - **A.** Gases can be poured.
   - **B.** Gases have a definite shape.
   - **C.** Gases fill the shape of any container they are put in.
   - **D.** Gases do not have a definite shape.

5. Which two properties of matter make it possible to make star-shaped ice cubes? Choose two answers.
   - **A.** Liquids take the shape of whatever container they are poured into.
   - **B.** Gases spread out to fill any container.
   - **C.** Solids have a definite shape.
   - **D.** Gases have no definite shape.

6. A group of classmates would like to put on a play to act out the states of matter. They will use their bodies to model the arrangement of particles in a solid. Choose the answer that describes how they could use their bodies to model a solid correctly.
   - **A.** The students would stand with their bodies spread out far apart around the room.
   - **B.** The students would stand with some space between each other, near to one another but not close enough that they could reach out and touch another student.
   - **C.** Some students would remain in the classroom, while others would move into the hallway.
   - **D.** The students would stand very closely together, packed tightly into a small area.

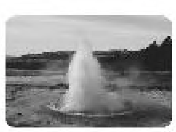
Concept Assessment
Unit 2, Concept 1: Matter in the World around Us

Name ______________________ Date ______________

7. There are three different states of water. The following images are examples of water in its different states. Next to each example image, write the letter of the explanation that describes its current state.

   - **A.** Tightly packed water particles that retain a shape.
   - **B.** Loosely packed water particles that take on the shape of their container.
   - **C.** Loosely packed water particles that do not have a definite shape or volume.


B


C


A


B


A


C

Concept Assessment
Unit 2, Concept 1: Matter in the World around Us

Name ______________________ Date ______________

8. Matter is ______.
   - **A.** anything in the world
   - **B.** anything that has mass and takes up space
   - **C.** only water in different states
   - **D.** only solids

9. Matter can change from one state to another.
   - **A.** true
   - **B.** false

10. How can a model be helpful?
   - **A.** Models give us step-by-step instructions about how to build something.
   - **B.** Models make something look better than it does in real life.
   - **C.** Models always make something smaller than it is in real life.
   - **D.** Models can help us see things that are too small or too big to observe.

Concept Assessment
Unit 2, Concept 2: Describing and Measuring Matter

Name ______________________ Date ______________

Instructions
Please answer each question carefully.

1. A scientist is comparing three common materials. She has a sample of each material that is exactly 10 cc (cubic centimeters). Using what you know about matter, fill in the table with the properties of each material.

smooth	rough	brown	gray
silver	26g	6g	10g

Material	Texture	Color	Mass of 10cc sample
Cardboard	smooth	brown	6g
Large Coin	smooth	silver	26g
Granite Rock	rough	gray	10g

2. A student wants to make a shelf that will display some objects in her room. She needs to decide which material would make the best shelf. She also wants to be sure the shelf will securely hang on the wall. She needs to make sure the shelf will both fit all her things and safely hold up what she wants to put on it. Which characteristics of the shelf's matter are critical for her to measure? Choose all that apply.
   - **A.** length
   - **B.** color
   - **C.** mass
   - **D.** texture

Concept Assessment
Unit 2, Concept 2: Describing and Measuring Matter

Name ______________________ Date ______________

3. Which of the following would be a scientific description of the properties of a crystal of salt?
   - **A.** It is beautiful.
   - **B.** It could be salt.
   - **C.** I'm not sure what it is.
   - **D.** It is solid, square, and clear.

4. You can describe fabric as rough, fuzzy, smooth, or silky. Which property of matter is this?
   - **A.** density
   - **B.** shape
   - **C.** mass
   - **D.** texture

5. Read the text. Underline the words and phrases that describe the properties that make cardboard a good choice for making a box.

   All materials have advantages and disadvantages. Materials may be strong or weak. Some materials are better for some uses than others. Heavy rocks and metals work for many uses. Paper and cardboard work for other uses. Cardboard is a better material for a box than glass. Cardboard is thin and flexible. However, it can get ruined if it gets wet. Because cardboard is not rigid, it is easy to cut and fold. However, it may break when it is used to hold very heavy items.

Concept Assessment
Unit 2, Concept 2: Describing and Measuring Matter

Name ______________________ Date ______________

6. Which of the following are two examples of physical properties?
   - **A.** ability to burn
   - **B.** ability to rust
   - **C.** blue
   - **D.** round

7. ______ changes describe how matter interacts with other matter.
   - **A.** chemical
   - **B.** physical
   - **C.** melting
   - **D.** breaking

8. Mass is a measurement of ______.
   - **A.** the odor of matter
   - **B.** the length of matter
   - **C.** the amount of matter
   - **D.** the color of matter

9. Volume is the amount of ______ that matter takes up.
   - **A.** time
   - **B.** space
   - **C.** temperature
   - **D.** water

10. Gas has mass.
   - **A.** true
   - **B.** false

Safety in the Science Classroom

Following common safety practices is the first rule of any laboratory or field scientific investigation.

Dress for Safety

One of the most important steps in a safe investigation is dressing appropriately.

- Use gloves to protect your hands and safety goggles to protect your eyes when handling chemicals, liquids, or organisms.
- Wear proper clothing and clothing protection. Tie back long hair, roll up long sleeves, and if they are available, wear a lab coat or apron over your clothes. Always wear close-toed shoes. During field investigations, wear long pants and long sleeves.

Safety Goggles

Be Prepared for Accidents

Even if you are practicing safe behavior during an investigation, accidents can happen. Learn the emergency equipment location, if available, and how to use it.

Most importantly, when an accident occurs, immediately alert your teacher and classmates. Do not try to keep the accident a secret or respond to it by yourself. Your teacher and classmates can help you.

Practice Safe Behavior

There are many ways to stay safe during a scientific investigation. You should always use safe and appropriate behavior before, during, and after your investigation.

- Read all of the steps of the procedure before beginning your investigation. Make sure you understand all the steps. Ask your teacher for help if you do not understand any part of the procedure.
- Gather all your materials and keep your workstation neat and organized. Label any chemicals you are using.
- During the investigation, be sure to follow the steps of the procedure exactly. Use only directions and materials that have been approved by your teacher.
- Eating and drinking are not allowed during an investigation. If asked to observe the odor of a substance, do so using the correct procedure known as wafting, in which you cup your hand over the container holding the substance and gently wave enough air toward your face to make sense of the smell.
- When performing investigations, stay focused on the steps of the procedure and your behavior during the investigation. During investigations, there are many materials and equipment that can cause injuries.
- Treat animals and plants with respect during an investigation.
- After the investigation is over, appropriately dispose of any chemicals or other materials that you have used. Ask your teacher if you are unsure of how to dispose of anything.
- Make sure that you have returned any extra materials and pieces of equipment to the correct storage space.
- Leave your workstation clean and neat. Wash your hands thoroughly.

A

arteries
blood vessels that carry blood away from the heart

C

chemical change
a chemical reaction; a process that changes substances into new substances

chemical properties
characteristics of a substance that are measurable or observable during a chemical reaction; these include acidity, flammability, reactivity and so on

circulatory system
the system that transports blood and other fluids throughout the body

climate
the average weather conditions in an area

compound
a chemical combination of two or more elements

conservation
the act of preserving natural resources, the environment, or other valuable commodities

consumers
organisms that eat other living things to get energy; an organism that does not produce its own food

cycle
a process that repeats

D

decomposers
organisms that carry out the process of decomposition by breaking down dead or decaying organisms

digestive system
the body system that breaks down food into tiny pieces so that the body's cells can use it for energy

dispersal
the distribution of items, such as seeds, over a wide area, away from the point of origin

E

ecosystem
all the living and nonliving things in an area that interact with each other

energy
the ability to do work or cause change; the ability to move an object some distance

F

food chain
a model that shows one linear set of feeding relationships and the movement of energy between living things

food web
a model that shows many different feeding relationships among living things

friction
a force that opposes the motion of a body across a surface or through a gas or liquid

G

gas
a state of matter without any defined volume or shape

germinate
the moment in a plant's life cycle when it sprouts and begins to grow from a seed

glucose
plant sugars that are a product of photosynthesis; glucose provides energy for the plant to grow and reproduce

H

habitat
the location in which an organism lives

heat
the transfer of thermal energy

I

interact
to act on one another

L

light
waves of electromagnetic energy; electromagnetic energy that people can see

liquid
a state of matter with a defined volume but no defined shape

M

mass
the amount of matter in an object

material
matter that can be used to create things

matter
material that has mass and takes up some amount of space

measure
to use a tool to learn more about the volume, length or weight of an object

melt
to change a substance from solid to liquid

microorganisms
organisms that are too small for people to see with only their eyes

microplastics
tiny fragments of plastic, less than 5 mm in diameter, a product of larger pieces of plastic that have been weathered and broken down, increasingly found in many waterways, harmful to animals and people

mixture
a combination of substances that can be physically separated from one another

model
a drawing, object, or idea that represents a real event, object, or process

N

nursery
an area in an ecosystem that is suitable for young living things to grow into mature organisms

nutrients
a substance such as a fat, a protein, or a carbohydrate that a living thing needs to survive

P

particle
something that is very tiny

phloem
vascular tubes in a plant that transport sugars made during photosynthesis from the leaves to the rest of the plant

photosynthesis
the process through which plants and some other organisms use the energy in sunlight to make food

physical change
a change in matter that does not affect its chemical composition

plant
an organism that is made up of many cells, makes its own food through photosynthesis, and cannot move; a member of kingdom Plantae

pollution
harm to air, water, or soil by substances that can harm living things

population
the group of organisms of the same species living in the same area

predators
animals that hunt and eat other animals

prey
an animal that is hunted and eaten by another animal

producers
organisms that make their own food; organisms that do not consume other plants or animals

property
a characteristic or quality of a material

R

restoration
the process of returning an environment to its natural state, usually following degradation by humans

S

scavengers
organisms that feed on the remains of other organisms

solid
matter with a fixed volume and shape

state of matter
a particular form that matter can take; the three main states of matter are solid, liquid, and gas

stem
the part of a plant that grows away from the roots; supports leaves and flowers

stomata
pores on the surface of a plant that allow gases to move into and out of the plant (related word: stoma)

substance
the physical matter of which living or nonliving things are composed

survive
to continue living or existing: an organism survives until it dies; a species survives until it becomes extinct

system
a group of parts that work together to function or perform a task

T

thermal energy
energy in the form of heat

V

veins
blood vessels that carry blood toward the heart

vessels
tubes in an organism through which life-sustaining materials are transported

volume
the amount of space that an object occupies, measured in liters or centimeters cubed

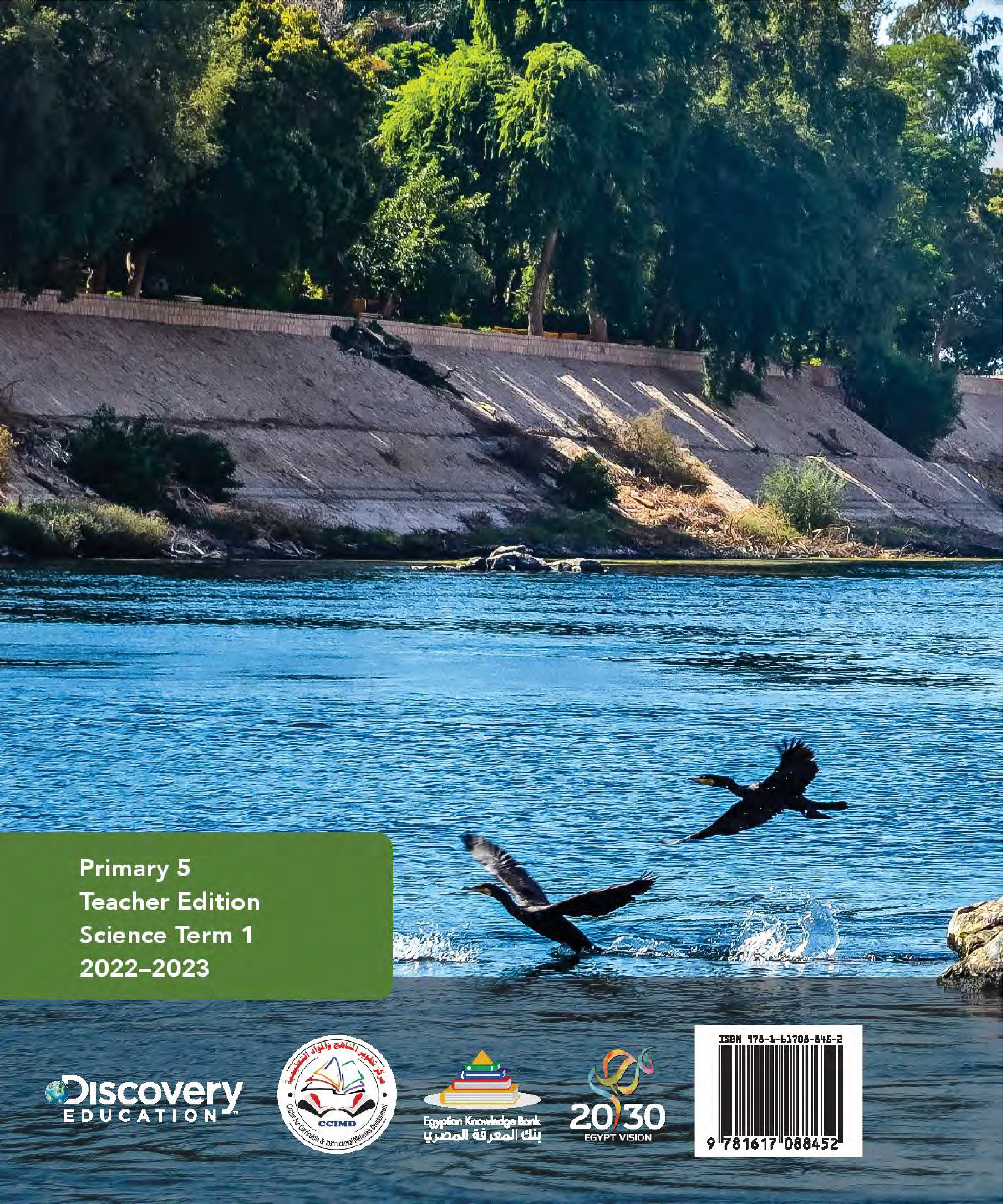
W

water vapor
the gaseous form of water; produced when water evaporates

X

xylem
vascular tubes in a plant that transport water and minerals obtained by the roots to the rest of the plant

Index



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